POWER

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The Outlook for the Power Plant Engineer

OUR correspondence columns have contained numerous contributions, some of them discouraged and pessimistic, about the prospects of the power-plant engineer.

The position and status of the "running engineer" has changed materially in the past score of years.

So far as he has remained simply a hand worker, an "engineman," an attendant upon the momentary requirements of running machinery, his standing is relatively less desirable and important than it used to be.

The centralization of power, the displacement of numerous reciprocating engines, each with its problems of valve and bearing adjustment and alignment by the steam turbine and the displacement of the numerous forms of mechanical transmission by electric generators and motors, whose mechanism and principles—both turbine and motors—are often to him profound mysteries, have reduced him more than ever to the status of just a "hand."

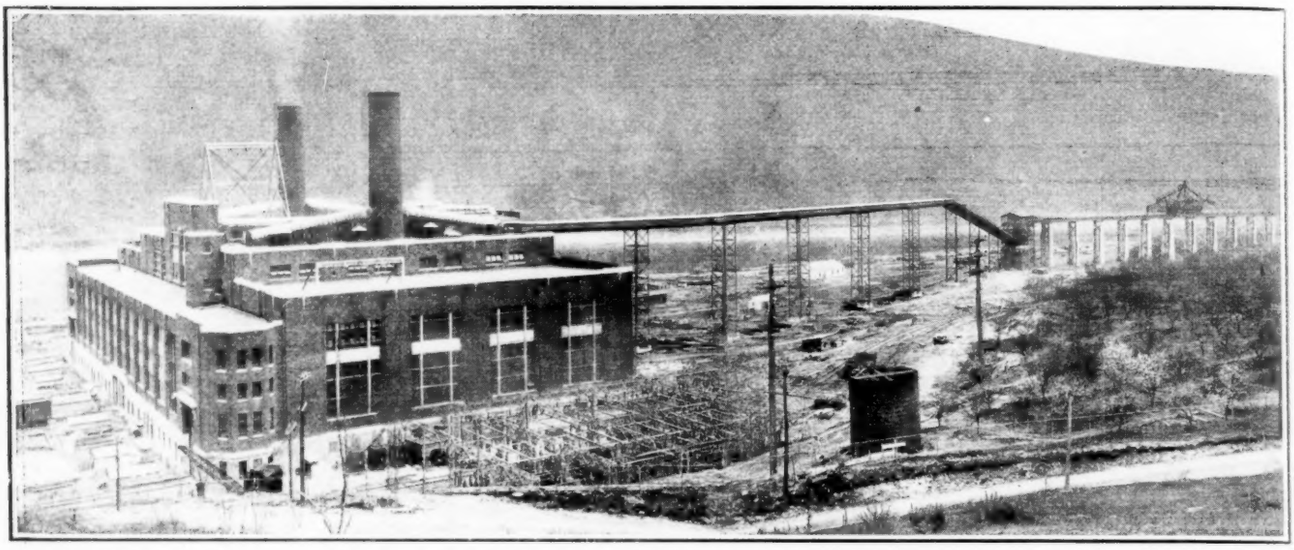
And unskilled or little skilled labor finds more profitable employment in other lines.

But the electricity that has made such a profound difference in power-plant practice, that has made the distribution and application of power so simple as to magnify its use by leaps and bounds is not primary power.

Behind every generator there is a prime mover of some sort, and somebody has got to engineer them.

With the growing magnitude and complexity of power plants, increased speeds and pressures and temperatures, increased rates of driving, increased opportunities for intelligent combination of power and heating services, increased demand for and importance of efficiency, there is more for the man in responsible charge of the power plant to know and to do, a better chance for high-class executive and professional service and a better prospect for recognition and emolument than ever before since steam began to do the work of the world.

F. R. Low



Stanton station of the American Gas & Electric Company.

Stanton Base-Load Plant Burning Anthracite Culm

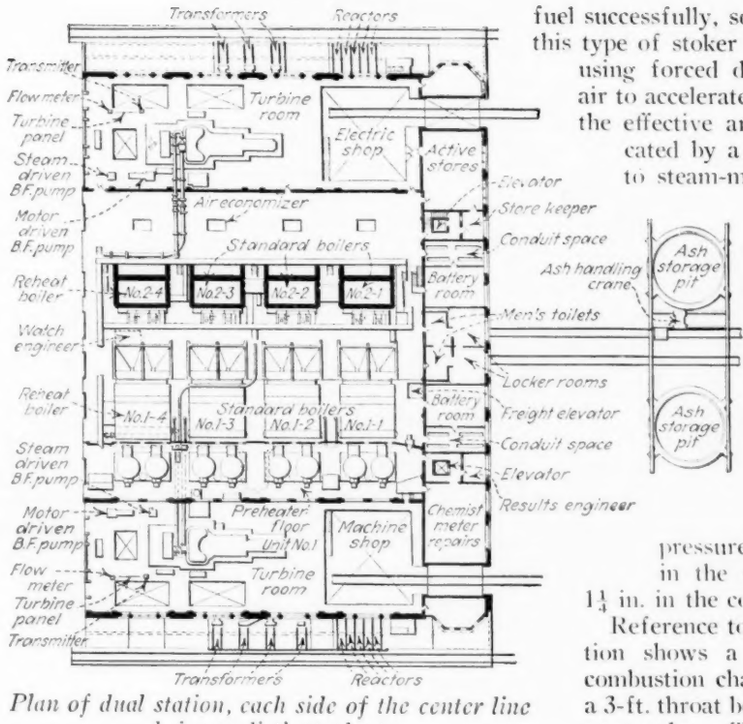
ON THE Susquehanna River three miles north of Pittston in the heart of the anthracite district, the initial two-unit 90,000-kw. installation of the new Stanton base-load plant has been placed in operation. Designed to utilize the mountains of anthracite culm in this region, the combustion problem has been solved in an interesting way; a new combination of air preheater and air-water economizer that will reclaim the heat in the stack gases without subjecting the equipment to corrosion has been incorporated, and the station is unusual in that it has been divided into two identical parallel plants with the center line running lengthwise through the middle of the boiler-room firing aisle. This arrangement was chosen as the plant was designed to feed two separate systems and was a joint undertaking of the American Gas & Electric Company and the Pennsylvania Power and Light Company.

Each side has a 45,000-kw. turbine-generator with condenser, pumps and other auxiliary equipment; three standard and one reheat boilers; coal conveyor and high-tension yard. The two parts will function individually, although for emergency interchange they are connected physically, both steam and electrically — the steam piping, feed pumps, water supply, makeup, etc., all being interconnected, while the switchyards are joined by a tie line on the high-tension side. From the one side current in bulk will be carried across the river to the high-tension system of the Scranton Electric Co., a subsidiary of the American Gas & Electric Co., and from the other yard transmission lines lead out over the hills to serve the Pennsylvania Power and Light Company.

Present plans call for four units on either side, giving a combined ultimate capacity of 360,000 kw. The coal unloading, handling and storage system has been constructed for eight units and for

INITIAL two-unit installation of station designed for eight units and capacity of **360,000** kw., arranged four units on a side into two identical plants physically interconnected for emergency interchange of service. The burning of anthracite culm on forced-draft chain grates is facilitated by the use of two combustion chambers separated by a **3**-ft. throat in which opposing blast nozzles introduce air preheated to **500** deg. For introduction under the stoker the air is tempered to **350** deg. by an air-water economizer. This combination of air heater and economizer was designed particularly to eliminate the usual difficulties from corrosion. Steam is bled at three points, two lines for heating the feed water and providing evaporator steam, and the third to supply the steam-jet air pumps. Reheat boilers are used.

the most part the circulating-water system outside the building for condensing purposes. From the intake crib at the river, which is provided with traveling screens in single file and trash racks, two concrete tunnels lead to a cross tunnel at the plant from which two tunnels lead out on either side, each to supply a pair of units. From each of the eight condensers of the completed plant a separate discharge tunnel will pass to a central sealing well from which gravity will carry the water back to the river through a twin tunnel.

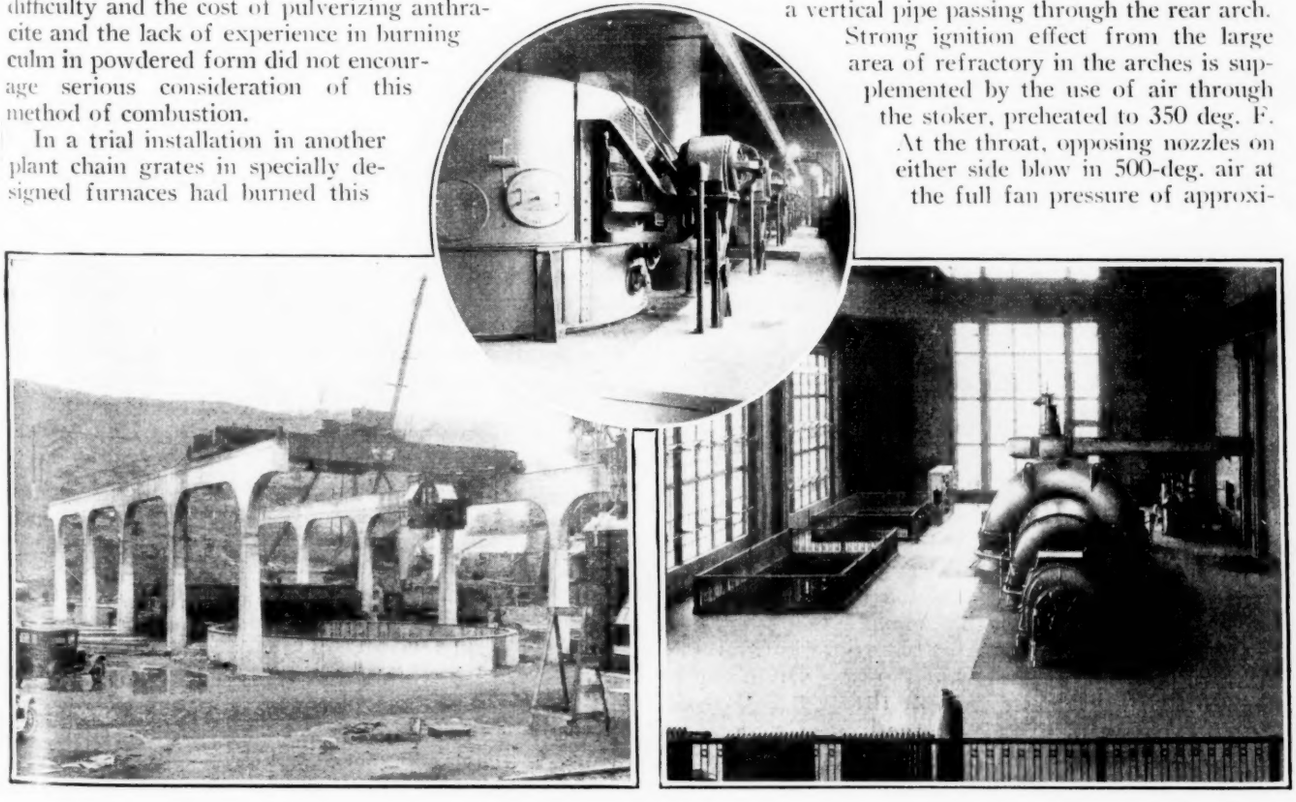


Plan of dual station, each side of the center line being a distinct plant

In the boiler room one of the difficult problems that had to be solved was the successful burning of the anthracite culm, which for years had been discarded as waste material from the mines in this district. Although the culm contains from 9,000 to 10,500 B.t.u. per lb., it has an ash content of 20 per cent and moisture running from 12 to 14 per cent. About one-fifth of the culm will pass through a $\frac{3}{16}$-in. screen. Although the fuel is already finely divided, the difficulty and the cost of pulverizing anthracite and the lack of experience in burning culm in powdered form did not encourage serious consideration of this method of combustion.

In a trial installation in another plant chain grates in specially designed furnaces had burned this fuel successfully, so it was logical that this type of stoker should be installed, using forced draft and preheated air to accelerate combustion. That the effective area is large is indicated by a ratio of grate area to steam-making surface of 1 to 31. Longitudinally, the stoker is divided into six zones; it is 24 ft. wide and is driven from one side by a direct-current motor hand-regulated by a drum-type controller. An air pressure of $3\frac{1}{2}$ in. is carried in the windbox and about $1\frac{1}{4}$ in. in the compartments.

Reference to the sectional elevation shows a furnace with two combustion chambers separated by a 3-ft. throat between the front and rear arches. The long arches serve the double purpose of reflecting the heat on the fuel bed and retaining much of the "fly" fuel in the primary combustion chamber. The fine particles of carbon that are carried unburned through the boiler collect in a soot hopper at the gas outlet and are returned to the fuel bed by means of a horizontal screw conveyor which transfers the hopper contents to a vertical pipe passing through the rear arch. Strong ignition effect from the large area of refractory in the arches is supplemented by the use of air through the stoker, preheated to 350 deg. F. At the throat, opposing nozzles on either side blow in 500-deg. air at the full fan pressure of approxi-



Ash-handling crane serving two sluicing pits. End of turbine room with 50,000-kw. unit in operation (Circle)—Row of air preheaters with integral forced- and induced-draft fans

mately 7 in. The effect is similar to that of a Bunsen burner. A thorough mixture of the gases and highly heated air is effected, and combustion is completed in the upper chamber. This type of furnace requires headroom from the floor to the bottom of the front uptake header of 30 ft. 10 in. and 16 ft. additional to the center line of the boiler drum.

The pressure at the superheater outlet is 650 lb. and at the turbine throttle 600 lb. The final steam temperature is 750 deg. F. With surface totaling nearly 18,000 sq.ft. the normal steaming capacity will be 175,000 lb. per hour. The foregoing data apply to the standard boilers, of which there are three, and one reheat boiler serving each turbine.

Recovering the waste heat in the flue gases without encountering the usual troubles from corrosion, particularly at the lower temperatures of the gases, was a problem ingeniously solved in the Stanton plant. Large air preheater surface aggregating 81,000 sq.ft. in two rotary units per boiler recovers all the heat desirable from the stack gases and sufficient to heat the combustion air to 500 deg. F. This temperature is excessive for chain grates, so the air is tempered to 350 deg. in an air-water economizer before passing on to the stoker, and the temperature of the feed water raised about 40 deg. With clean air on one side and clean water on the other side of the economizer surface, no trouble from corrosion is anticipated. Thus a portion of the waste heat is returned to the feed water and the balance used to improve combustion. The present plant is the first in which this combination has been used throughout.

The forced- and induced-draft fans are integral with the preheater, and one 175-hp. slip-ring variable-speed motor drives the complete unit.

Mention should be made of the control stations, of which there is one for every two boilers. On facing boards midway between and in front of the respective boilers are mounted the controls for the fan- and clinker-grinder motors and all instruments, such as draft and pressure gages, recording thermometers for the preheated air, flue gases and feed water. In the same area are the stoker-motor controllers and the hand-control valves for the feed water, so that the control and the instruments for each pair of boilers are all within the limited area of the control station and readily accessible to the one man operating the two boilers.

For the two sides of the plant a dual system of coal handling has been provided that has ample capacity to supply 600 tons of coal per hour to the plant and storage facilities for 300,000 tons. The culm is received by rail and by a car dumper transferred into a large hopper feeding onto either one of two conveyor belts serving either side of the plant. Over a trestle in the storage area these belts pass to a transfer house, where the coal for immediate use is passed to a second pair of belts rising to a level above that of the bunkers and then running horizontally into the station. This arrangement provides for the anticipated extension of the plant without disturbing the coal-handling system. Each belt delivers to its respective side of the station, but trippers and spouts are so arranged that in an emergency either belt may serve the opposing half of the plant.

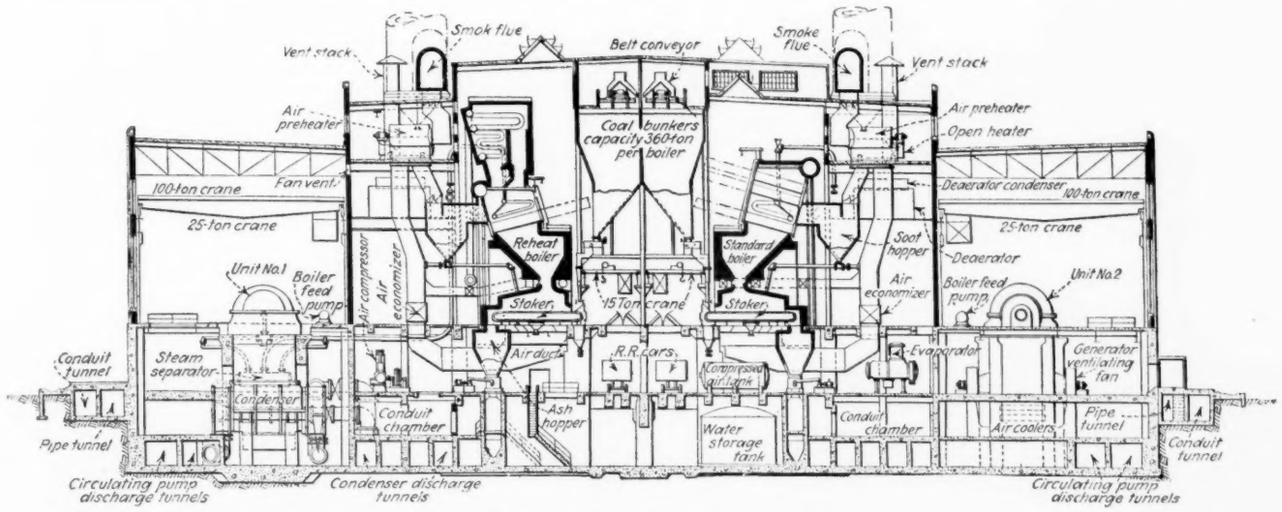
The central firing aisle of the boiler room is the dividing line between the two plants

On the trestle another new feature of the coal-handling system is a special storage crane equipped with a shuttle conveyor to permit placing the coal over a larger area. From the belts the coal is tripped to the crane for storage on either side and by means of a clamshell bucket on this same crane is reclaimed from storage and placed on the belts. Direct current for the crane is supplied by a motor-generator set in the transfer house, and here also is the control equipment for the coal-handling system.

Track scales are located at the car dumper, automatic electric scales are installed on each of the belts into the building, and individual scales, two for each boiler, weigh the fuel as it passes to the stoker hopper, so that a complete and full check is maintained on the fuel received and consumed.

The ashes, after passing through clinker-grinders, are carried by low-pressure gravity sluices, one under each row of boilers, to concrete pits in the yard. Each pit is

40 ft. in diameter and 30 ft. deep below the sluiceway. Both pits are served by a traveling crane equipped with a clamshell bucket to load the ash onto railway cars for disposal. Excess water in the pits is pumped to waste.



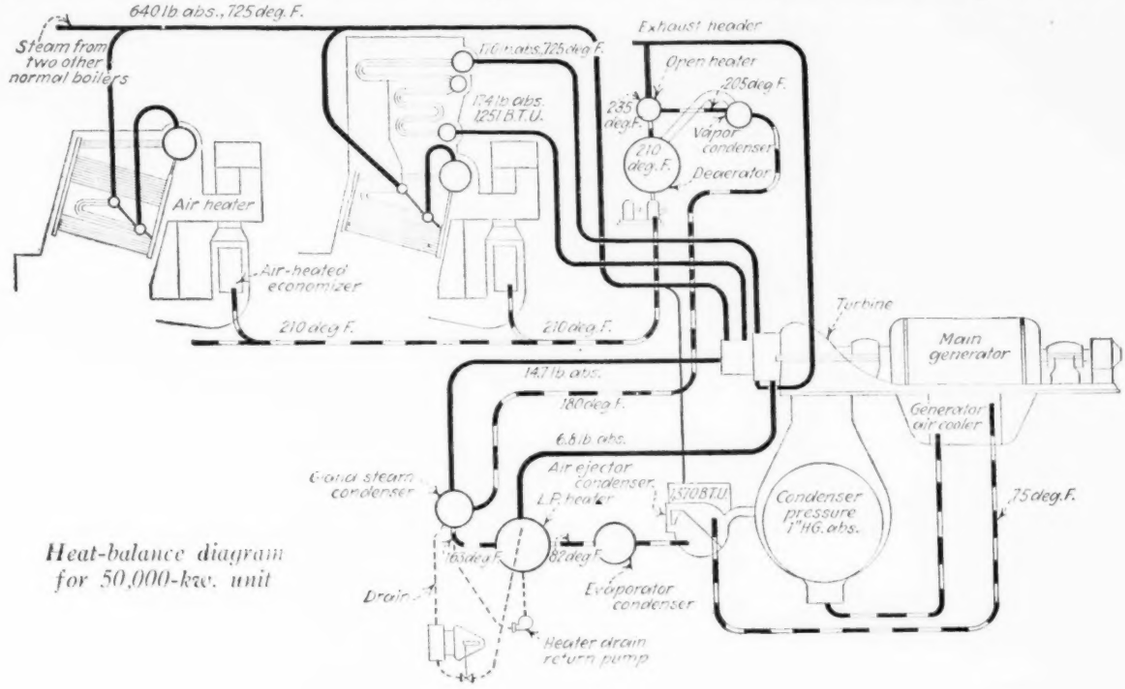
Sectional elevation through power plant

no attempt having been made to reclaim and recirculate the ash-carrying medium.

Station heat balance is based on bleeding steam from the turbine at three points, although steam from two stages only is used to heat the feed water directly. The main supply for the feed water comes from the sixteenth-stage bleeder line drawing steam from the turbine at 6.8 lb. abs. and a heat content of 1,140 B.t.u. This extraction heater, in conjunction with the turbine gland steam condenser and the various other agencies from which heat is absorbed, such as the generator air cooler, the condensers of the steam-jet air pumps, evaporator and deaërator, and the exhaust steam available to the open heater, bring the feed water to the air-water economizer at a temperature of 210 deg. F. The economizer adds 40 deg., so that the feed water enters the boilers at a temperature of 250 deg. The path of the condensate is indicated in the heat-balance diagram. Condensation from the gland condenser and the low-pressure heater is pumped back into the system beyond these units. The gland condenser is vented to the heater and the latter to the main condenser.

The open heater takes the exhaust steam available, should the turbine-driven boiler-feed pump be operating, and also draws from the twelfth-stage bleeder line supplying the evaporator. From the third bleeder point on the turbine steam is supplied to the steam-jet air pumps.

It should be explained that each plant unit is served by two boiler feed pumps of 800-g.p.m. capacity operating against a head of 800 lb. One is a six-stage motor-driven pump and the other a single-stage Weir pump driven by a turbine. All other auxiliaries in the plant are motor-driven, so that the boiler-feed pumps, in conjunction with the twelfth-stage bleeder line, give the



Heat-balance diagram for 50,000-kw. unit

PRINCIPAL MECHANICAL EQUIPMENT OF STANTON POWER STATION

GENERAL

Location	Pittston. Pa.
Water source	Susquehanna River
Capacity present installation, kw	100,000
Ultimate capacity, kw	360,000
Owners	American GasandElectricCo. Pennsylvania Pr. & Lt. Co.
Consulting engineers	Sargent & Lundy, Inc.

PRESENT BUILDING

Volume, cu.ft. per kilowatt:	
Boiler room	43.3
Turbine room	19.4
Laboratory and offices	10.9
Shops	8.3
Crib house	2
Total	83.9
Available for future	18.3
Net total	65.6

STANDARD BOILERS AND SUPERHEATERS

Manufacturer	Babcock & Wilcox Co.
Number	6
Water-heating surface, sq.ft.	17,962
Superheating surface, sq.ft.	2,800
Steam pressure at superheater outlet, lb. gage	650
Steam temperature, deg. F	750
Steaming capacity, lb. per hour	175,000

REHEAT BOILERS AND SUPERHEATERS

Manufacturer	Babcock & Wilcox Co.
Number	2
Water-heating surface, sq.ft.	5,978
Superheating surface, sq.ft.	1,600
Reheating surface, sq.ft.	13,481
Steaming capacity, lb. per hour	83,000
Reheating capacity, lb. per hour	349,000

BOILER AUXILIARIES

Economizers, air and water type	Babcock & Wilcox Co.
Number	8
Surface in each, sq.ft.	3,011
Air preheaters, two per boiler	The Air Preheater Co.
Type	Ljungstrom, rotary
Number	16
Heating surface of each, sq.ft.	40,500
Forced-draft fans, 16, capacity per fan against 6.7 in. static press, c.f.m.	33,000
Induced-draft fans, 16, capacity per fan, press 3.3 in., c.f.m.	56,000
Drive of unit, air heater and integral fans, motor, hp.	175
Stokers, forced-draft, chain grate	Babcock & Wilcox Co.
Number	8
Area per stoker, sq.ft.	576
Ratio stoker area to water heating surface	1 to 31
Stacks	Two, self-supporting, steel
Diameter, inside, ft.	16
Height above boiler-room floor, ft.	150

FUEL

Kind	Anthracite culm
Heat value, B.t.u. per lb	9,000 to 10,500
Ash, per cent	20
Moisture, per cent	12 to 14

COAL HANDLING SYSTEM

Car unloader	Wellman-Seaver-Morgan Co.
Belt conveyors, two, 36-in., 350 ft. long Belt conveyors, two, 36-in., 1,150 ft. long Belt conveyors, two, 36-in., 800 ft. long	American Gas & Electric Company layout
Storage crane	Designed by American Gas & Electric Co.
Weightometers, two	Merrick Scale Mfg. Co.
Bunkers, steel, 360 tons per boiler	American Bridge Co.
Coal scales, aut. elec., two per boiler	Richardson Scale Co.

ASH HANDLING

Storage per boiler hopper, tons	38
Clinker grinders, motor operated	Westinghouse
Sluicing system	Designed by Sargent & Lundy, Inc.
Ash crane, 1½ cu.yd., 44 ft. span	Whiting Corp.
Ash disposal pumps, two, motor driven	American Manganese Steel Co.

FEED WATER HEATERS

Extraction, l.p., two, 1,800 sq.ft.	Wheeler Condenser & Eng. Co
Gland steam condensers, two, 1,800 sq.ft.	Wheeler Condenser & Eng. Co.
Open heater, 355,000 lb. per hour	Elliott Co.
Deaerator with vapor condenser, 350,000 lb. per hour	Elliott Co.
Feed-water regulators, water level and dif. press	S-C Regulator Mfg. Co.

EVAPORATOR

Manufacturer	Wheeler Condenser & Eng. Co.
Number and type	One, low-pressure, quadruple effect
Capacity, lb. water per hr	40,000

PUMPS

Boiler feed, two, six-stage, motor driven	A. S. Cameron
Capacity, 800 lb. head, g.p.m.	800
Boiler feed, two, single-stage, Weir, 35-hp. turbine dr.	Bethlehem Shipbuilding Corp.
Capacity, 800 lb. head, g.p.m.	800
Heater condensate pumps, 2, s.s. cent.	Allis-Chalmers Mfg. Co.
Capacity, 160 ft. head, g.p.m.	100
Drive, motor, hp.	15
Make-up pumps, 3, s.s. cent.	Allis-Chalmers Mfg. Co.
Capacity, 190 ft. head, g.p.m.	200
Drive, motor, hp.	30
Primary make-up pumps, 4 s.s. cent.	Yeomans Bros. Co.
Capacity, 123 ft. hd., g.p.m.	20
Drive, motor, hp.	7½
Deep-well pumps, 3, vert. multi-stage.	American Well Works
Capacity, 210 ft. head, g.p.m.	1,000
Drive, motor, hp.	100
Service pumps, 3, s.s. cent.	Allis-Chalmers Mfg. Co.
Capacity, 231 ft. head, g.p.m.	1,500
Drive motor, hp.	150
Hot water circ. pumps, 2, s.s. cent.	Allis-Chalmers Mfg. Co.
Capacity, 50 ft. head, g.p.m.	500
Drive, motor, hp.	15
Bilge pumps, 5 sets, 500 g.p.m., 15-hp. motor	Yeomans Bros. Co.
Ice melting pump, one, 72,000 g.p.m., 15 ft. hd., 400 hp. motor	Wheeler Condenser & Eng. Co.

MAIN GENERATING UNITS

Manufacturer	General Electric Co.
Number	2
Type	Single-cylinder, 3 bleeding points
Capacity, 85 per cent power factor, kw.	50,000
Steam pressure at throttle, lb. gage	628
Steam pressure at reheat, lb. gage	160
Steam pressure at exhaust, in. of Hg abs.	1
Steam temperature at throttle, deg. F.	725
Steam temperature before reheat, deg. F.	505
Steam temperature after reheat, deg. F.	725
Speed, r.p.m.	1,800
Type of generator	3 ph., 60-cycle, 11,000 v.
Ventilation	Closed system with fin, G. E. cooler and external fan with independent motor drive
Auxiliary generator	2,300 v., 2,300 kw. at 0.7 p.f., 3-ph., 60-cycle
Exciters	Two, direct connected, 250 v.-250 and 35 kw.

CONDENSERS AND AUXILIARIES

Manufacturer	Wheeler Cond. & Eng. Co.
Number and type	Two single-pass, surface
Surface, sq.ft.	33,000
Tubes, Admiralty mixture, sizes, in.	1-⅞-¾
Circulating pumps, one per unit, 72,000 g.p.m., 15 ft. hd. 450-hp. motor	
Hot well pumps, two per unit, 2-stage, 900 g.p.m., 100-hp. Allis motor	
Air pumps—Steam jet, 3 elements per unit, inter and after condensers	
Traveling screens, four, 50 ft. 3 in. by 7 ft., drive 10-hp. motor	Chain Belt Co.

CRANES

Manufacturer	Whiting Corp.
Turbine room, two, 60.5 ft. span, main hoist 100 tons, aux. hoist 10 tons	
Turbine room, two, 60.5 ft. span, 25 tons	
Boiler room, two, 16 ft. 3 in. span, 15 tons	
Pump room, one, 17 ft. 4 in. span, 15 tons	
Crib house, one, 24 ft. 7 in. span, 25 tons	
Ash handling, one, 44 ft. span, 1½ cu.yd. Kiesler clam shell bucket	

VALVES AND PIPING

Low-pressure gate	Kennedy Valve Mfg. Co.
High-pressure gate	Crane Co.
Motor-operated units, Dean	Cutler-Hammer Mfg. Co.
Nonreturn valves	Edward Valve & Mfg. Co.
Blowoff valves	Edward and Yarnall-Waring
Safety valves	Manning, Maxwell & Moore
Piping installed by	Pittsburgh Piping and Equipment Co.

MISCELLANEOUS EQUIPMENT AND MATERIALS

Boiler furnace arches	M. H. Detrick Co.
Oil purifiers, 4,300 gal. per hour	De Laval Steam Turbine Co.
Air Compressors, two angle compound, motor-driven	Sullivan Mach. Co.
Pipe covering	Ehert Magnesia Mfg. Co.
Masonry settings	National Power Construction Co.
Soot Blowers	Vulcan Soot Cleaner Co.
Water columns	Babcock Q Wilcox Co.
Storage tanks, two, 100,000 gal.	Chicago Bridge & Iron Works
Steam flow meters	General Electric Co.
Gages	Bristol Co.-Ashton Valve Co.
Recording thermometers	Bristol Co.-Leeds & Northrup Co.-Precision Instrument Co.
Load indicating system	Chas. Cory & Son, Inc.
Building heating equipment	Sargent & Lundy design Installed by Gaylord & Butler
Switch gear, Reyrolle	Allis-Chalmers Mfg. Co.
Switchboard	General Electric Co.
Switches, metal clad	A. Reyrolle & Co.
Main transformers	Westinghouse Elec. & Mfg. Co.
Auxiliary transformers	General Electric Co.
Outdoor high-tension circuit breakers	Westinghouse Elec. & Mfg. Co. and General Electric Co

flexibility needed to maintain the heat balance. Regulation of the boiler feed is maintained by water-level and differential-pressure regulators at each boiler.

Makeup water is secured from deep wells connected with a 100,000-gal. steel storage tank in the yard, from which water is piped to the evaporator and is available for other general uses. After passing through the evaporator, which is of the quadruple-effect low-pressure type having a capacity of 40,000 lb. per hour, the pure water is stored in a second 100,000-gal. steel tank in the yard and in seven large steel tanks in the basement of the building. The anticipated makeup of 1½ per cent of the total feed going to the boilers is pumped to the open heaters under float control.

In the high-pressure piping, conforming with late practice and A.E.S.C. standards, nothing unusual has been incorporated except that generous use has been made of motor-operated valves. This applies to all steam valves of 10-in. size and larger, the non-return valves on the boilers and the large valves on the condenser circulating-water system.

In the turbine rooms each of the main units is rated at 45,000 kw. at 85 per cent power factor. Steam is exhausted to a 33,000-sq.ft. horizontal single-pass surface condenser arranged for reversible flow during operation to remove débris or loose material that may be clogging the tubes. One circulating pump per unit is provided, with cross-connection between the two to provide for emergency service. The hotwell pumps are in duplicate, and the steam-jet air pumps are made up of three elements. Two of these elements will meet the service, so that one element is always in reserve.

The main generator delivers three-phase 60-cycle current at 11,000 volts. Coupled to the same shaft is the three-phase 60-cycle 2,300-volt 2,300-kw. (at 70 per cent power factor) auxiliary generator. Each generator has its direct-connected exciter, both being 250-volt machines rated at 250 and 35 kw. respectively. For generator cooling a closed system is used consisting of a fin-type cooler in the foundation under the generator and an external ventilating fan with independent motor drive.

Each main generator delivers directly to transformers in its respective yard, with the controlling oil switch on the high-tension side. The voltage is stepped up to 69,300 volts before delivery to a main or reserve bus supplying the outgoing overhead lines. Thus switching at generator voltage has been eliminated.

Practically all of the auxiliary motors rated at 35 hp. and above are 2,200-volt three-phase machines, either of the slip-ring or squirrel-cage type, depending upon the application, designed for full-voltage starting. They are supplied with energy from the 2,200-volt auxiliary power buses in the basements, which receive their energy from the auxiliary generators or from reserve auxiliary transformers on the main high-tension buses. Other motors in the plant, with the exception of certain direct-current motors, are 440-volt squirrel-cage machines.

In the 2,200-volt auxiliary service a departure is the use throughout of Reyrolle breakers. In effect they are ironclad oil disconnecting switches mounted on racks, eliminating the concrete cells used in former installations. These new switching devices allow for the isolation of any particular piece of electrical equipment.

Communication between the turbine and switchboard operators is effected by a load indicating system and automatic telephones. The benchboard has been discarded. All instruments, meters and control equipment are mounted on vertical panels. Here also distinction is made between the two sides of the plant. The various boards for each turbine room are arranged symmetrically on one side of a central dividing line. At present one operator and one dispatcher can take care of the two units.

The station was designed by Sargent & Lundy, Inc., in conjunction with the engineers of the American Gas & Electric Co., of which George N. Tidd is president. A great deal of credit for this project is due the late A. E. Johnson, chief mechanical engineer of the American Gas & Electric Co., whose untimely death last May was a great loss to his organization and to the engineering profession.

Power Plant Incinerator

IS THERE anything more displeasing than to go into a plant and see waste, rags and paper littered around the floor and in out-of-the-way corners? This is entirely unnecessary and usually leaves a bad impression of the men in charge.

In the Essex plant of the Public Service Electric and Gas Company of New Jersey, one or more men are engaged constantly in collecting and disposing of all refuse with the result that the plant always presents a

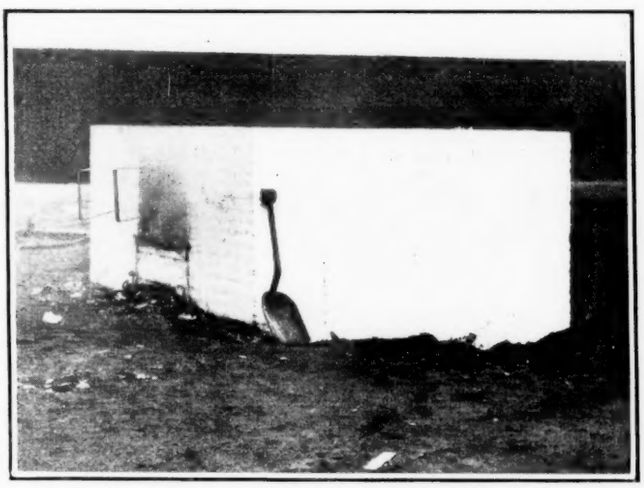


Fig. 1—Brick incinerator used by the Public Service Electric and Gas Company at its Essex plant

favorable appearance. A special incinerator has been erected in the rear of the power house to which all burnable waste materials from within the plant and the ground surrounding the power house are deposited and burned. This has eliminated the necessity of the refuse gatherers entering the boiler room and thus interfering with the boiler room activities. This incinerator is made of brick and is erected on the side of a fill. It is 8 ft. long by 7 ft. 8 in. wide and 10 ft. deep to the bottom of the ash pit. An iron grate installed 3 ft. from the bottom forms a furnace 7 ft. high and an ash pit 3 ft. in depth. The side walls are 12 in. thick and the 8 in. thick top is made of brick and cement reinforcement by 60-lb. T-rail. An 18-in. by 20-in. opening at the rear in front of the ash pit and a 24-in. by 30-in. opening in the top over the furnace provides for combustion air and smoke emission. A 28-in. by 38-in. iron door which opens downward and rests upon the ground on two angle feet provides a ready means for depositing the refuse.

Electric Elevator Signals

How Push-Button Annunciator Systems Operate*

By F. A. ANNETT
Power, Editorial Staff

GOOD elevator service cannot be rendered without an adequate and reliable signal system. Such a system must not only provide waiting passengers with a means of signaling their wants to the operator, but it should also indicate when and where they may expect a car. Unless the waiting passengers know where to look for a car, they may be giving their attention to something else when the car arrives at the floor and it may be necessary for the operator to call the passengers before they will know that a car is waiting for them. All such delays tend to reduce the efficiency of the service.

If the operator stops at the floor and leaves without picking up the passengers, it results in unsatisfactory service and complaints. The more closely the operators are in touch with the desires of the waiting passengers and the more exact knowledge the passengers have regarding the position of the cars, the more efficient will be the elevator service. Increasing the efficiency with which the passengers are handled is the equivalent of increasing the speed of the elevator cars. In local service this may be a very important item in maintaining good service, since a large portion of the time is spent at the landings and anything that can be done to reduce this time will improve and speed up the service.

What constitutes an adequate elevator signal system will depend upon the nature of the service, the number of cars, and their speed. Probably the first signal system was for the one who wanted the elevator to shout his or her wants up or down the elevator hoistway as the case might be. In some old buildings this ancient standby is still in vogue today. Fig. 1 shows the simplest form of a signal device, which consists of a push button at each floor and a bell located in the car or in the hoistway. When any one of the buttons is pressed a

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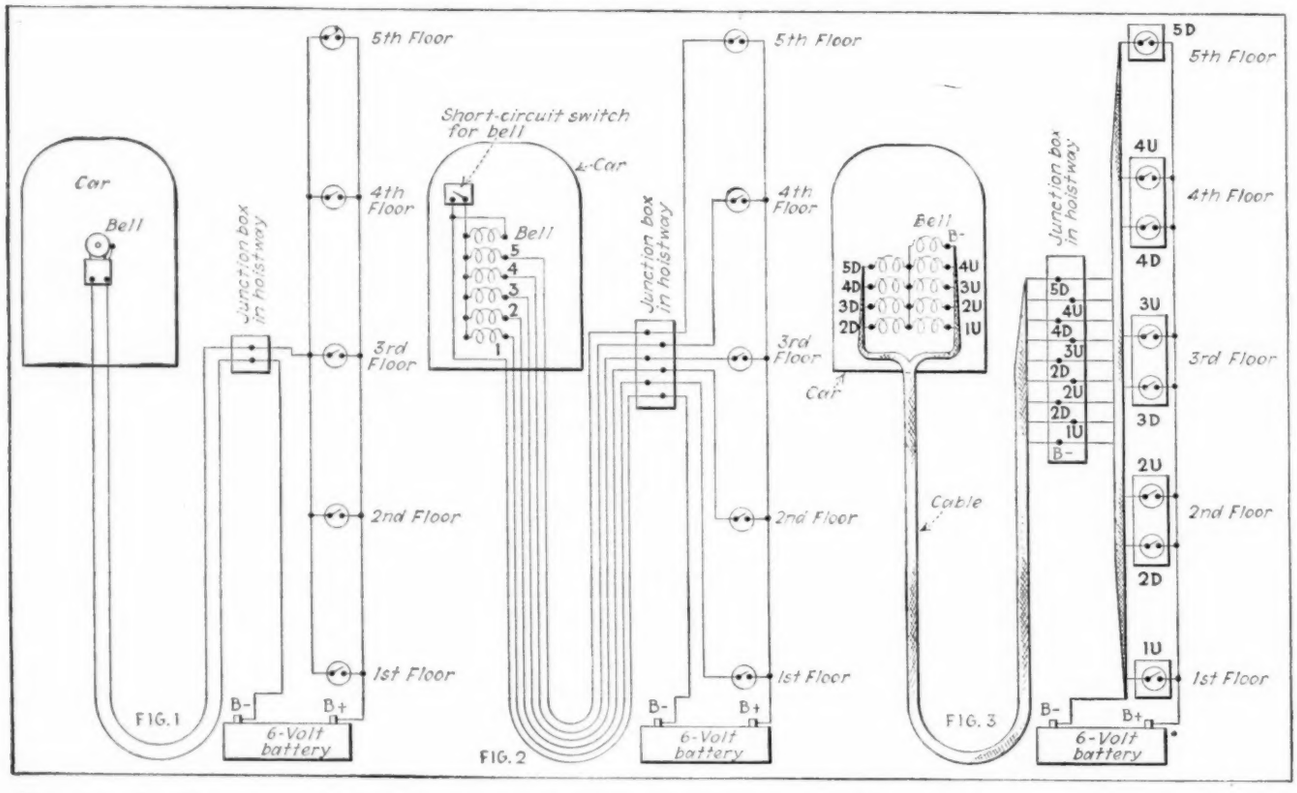
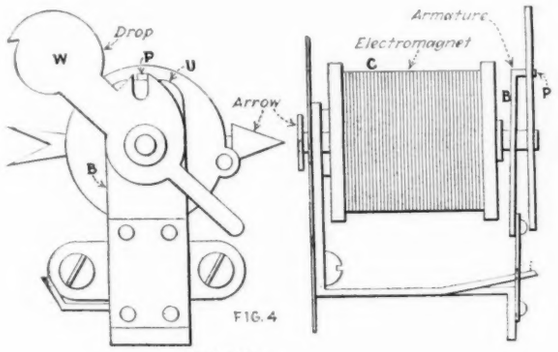
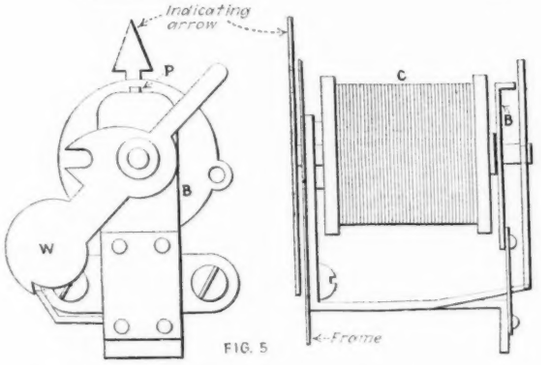


Figs. 1 to 3—Diagrams of bell and annunciator elevator-signal systems. Fig. 1—Bell and push-button system. Fig. 2—Single-bank annunciator system. Fig. 3—Up-and-down direction annunciator system

circuit is closed through the bell. For example, closing the fourth-floor button completes a circuit from the + side of the battery through the fourth-floor button, to the junction box in the hoistway, through the bell, and back to the — side of the battery. In some cases, such an arrangement is used on freight elevators either





Figs. 4 and 5—Diagram of annunciator drop with arrow indicator

to warn anyone who may be using the car that someone on another floor wishes to use it, or the bell may be used to signal the operator by ringing it a number of times corresponding to the number of the floor. Either method is very limited in its application and could scarcely, in the light of modern practice, be given the name of a signal system.

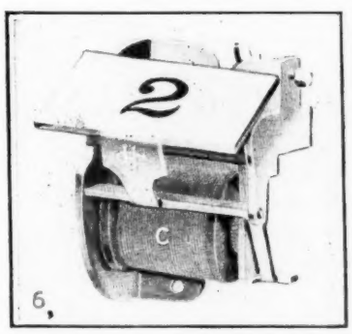
Some form of a drop annunciator provides a means of recording the calls made by waiting passengers, and can be used for passenger or freight service where only one or two cars are in use and the service is not exacting. A diagram of connections for an annunciator and bell is shown in Fig. 2. When the button at any of the floors is pressed, the bell will ring and the floor number will be registered on the annunciator. As an example, when the second-floor button is pressed a circuit is completed from the + side of the battery through the second-floor button, the No. 2 annunciator coil, the bell coil and returns to the — battery terminal. This releases the drop on the annunciator, which indicates the floor and rings the bell or buzzer to call the attention of the operator. One of the shortcomings of this system is that it does not indicate to the operator the direction in which the passengers wish to go. This practically limits the use of a single annunciator to installations having one elevator.

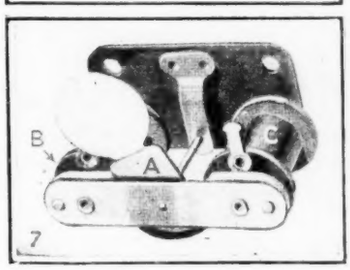
An up-and-down annunciator overcomes some of the foregoing difficulties. This type has two sets of indicators, one for up direction and one for down. At each floor, with the exception of the terminal landings, there are two buttons, one for up and the other for down motion. At the terminal landings there is only one button. At the top landing the button is to indicate down calls, and at the bottom landing the button indicates up calls. A diagram for such an arrangement is shown in Fig. 3.

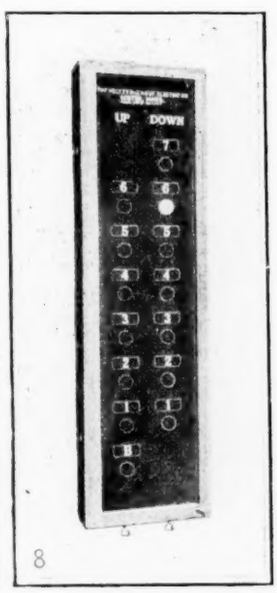
If the fourth-floor down button, Fig. 3, is pressed, a circuit is completed from the + side of the battery through button *4D* and to terminal *4D* in the hoistway junction box. From this box the circuit goes to the car, through annunciator coil *4D* and the bell coil, returning to the *B*-terminal of the hoistway junction box and to the battery. Energizing this circuit releases the annunciator drop and rings the bell, the latter attracting the operator's attention to the call.

A passenger pressing the second-floor up button would make a circuit from the *B*+ battery terminal through *2U* button to the *2U* terminal in the hoistway junction box. From this box the circuit continues through the *2U* coil of the annunciator and the bell coil returning to the *B*-terminal in the hoistway and the battery. This operation releases the *2U* indicator on the annunciator and rings the bell again calling the operator's attention. From the foregoing, it is seen that this system not only calls the operator's attention to waiting passengers, but also indicates the direction in which they wish to be taken.

On account of the greater information given by this system, it is sometimes used on two passenger elevators serving buildings where the service is not too exacting. When a double-drop annunciator is used on each of two elevators, the same push-button arrangement on the floors is used as in Fig. 3, and the annunciator in one car is connected as in the figure. The annunciator in the other







Figs. 6 to 8—Target-type drops and annunciator
Fig. 6—Gravity-type target which is mechanically reset. Fig. 7—Electrical reset type of target. Fig. 8—Up-and-down type annunciator using targets of the type shown in Fig. 7, but mechanically reset

car is connected to a junction box in the hoistway as in the figure, and the two junction boxes connected in parallel. For instance, terminal *5D* of one junction box is connected to *5D* in the other, *4U* to *4U*, *4D* to *4D*, and so on. With this connection, when any one of

the floor buttons is pressed, the call will be registered on both annunciators.

In some cases, the annunciator on each car is connected to the same junction box in one of the hoistways. This arrangement has the objection, in case of trouble on one car, of interfering with the operation of the other. If the junction box is in the hoistway of No. 1 car and the signal system to car No. 2 is in trouble, should it be necessary to test from the junction box to No. 2 annunciator it will require stopping car No. 1 to make the test. Likewise, it will be necessary to shut down car No. 1 to renew the traveling cable of No. 2 annunciator. For these reasons, it is best to provide a junction box in each hoistway and connect these in parallel, with a short length of cable.

An objection to the annunciator system is that there is no means of indicating to the operator of one car when the other car has answered a call. The annunciator does not automatically reset when a call is answered. Since they should not be reset until the operator has answered all the calls in one direction, there is no means of recording a call after the car has stopped at a floor. For instance, assume that the car has a call to stop at the third floor up and after answering this call continues in the up direction; if after leaving the third floor and before the annunciator is reset at the top floor, a passenger on the third floor presses the up button, this call will not be recorded on the annunciator. The drop for the third floor is in the call position from the previous call. When the operator, on reaching the terminal landing, resets the drops, no indication of the third-floor call is left. This difficulty is inherent in all drop annunciator

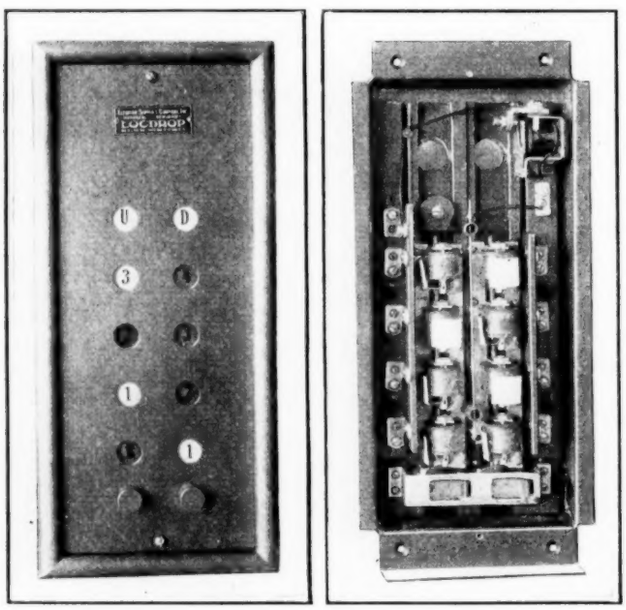


Fig. 9 (Left)—Annunciator with targets exposed back of call number. Fig. 10 (Right)—Annunciator, Fig. 9, with cover removed

systems and for this reason they are usually limited to single-elevator installations, although in some apartment houses annunciators of this type are used on elevators serving 15 or more floors and where two elevators are in use.

The type of bell used on the annunciator may vary with the conditions and the ideas of the one making the installation. Although a continuous ringing bell has the advantage of making certain of attracting the operator's attention to the call, it may be very annoying to the passengers in the car if someone at a landing persists in pressing the button until the arrival of the car. For this reason, sometimes, a short-circuiting switch, Fig. 2, is connected to the terminals of the bell, so that if the bell

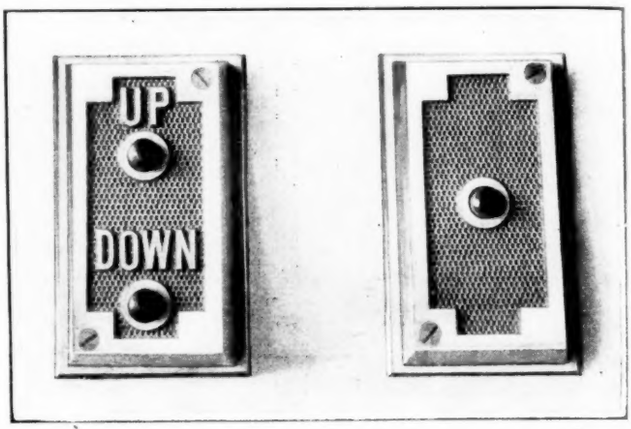


Fig. 11 (Left)—Up-and-down annunciator floor push button. Fig. 12 (Right)—Single-bank annunciator floor push button

becomes annoying it can be short-circuited and only the annunciator drops will operate.

A buzzer is of equal value to a bell in attracting the operator's attention, is not nearly so annoying to passengers, and is used extensively. The single-stroke bell is probably equal to any other noise device for attracting the operator's attention and is widely used.

Where no other source of power is available, dry cells are used extensively for operating the annunciator signals. These have the objection of failing at inopportune times if not given attention and renewed before they completely run down. They possess the advantage of being readily available and are easily and cheaply replaced. Where a storage battery is available for operating other low-voltage devices, the elevator signal system may be connected to a number of cells in this battery that will give the desired voltage. Although motor-generator sets are used extensively to operate the more elaborate signal systems for elevators, they are rarely used on such systems as previously described. Where alternating current is available, bell-ringing transformers are frequently used. On account of the inductance of the circuits, an alternating-current voltage about 100 per cent higher than the direct-current voltage should be used. That is, if 6-volt direct current is used, about 12- or 15-volt alternating current will be required. On some systems, 8-volt direct current is recommended and 24-volt alternating current.

For use in annunciators a great variety of drops have been developed, but the one shown in Figs. 4 and 5 will give the general principle. On one end of a shaft that extends through the coil is fastened an arrow, and on the other end of the shaft is a weight, *W*, arranged to turn the shaft about 90 deg. when free. In the off position the weight arm is held by a pawl, *P*, as indicated in Fig. 4. When coil *C* is energized by closing a push button, it attracts armature *B* and releases the weight arm *W*, and it drops to the position shown in Fig. 5. In doing this, the weight arm turns the arrow to a ver-

tical position and gives an indication of the call. When the button is released, coil *C* is de-energized and armature *B* returns to its normal position. Drops of this type are reset mechanically by the operator pushing up on a rod extending below the lower end or through the front of the annunciator case.

Where arrows are used to give the indication, the only change on the annunciator is the position of the arrows, which probably does not possess the qualities for attracting attention and being interpreted correctly as well as a change of color or the flashing of a number. To make the calls on annunciators more readily seen and correctly interpreted, a number of methods have been devised. One of these is shown in Fig. 6. In this design, when coil *C* is energized the white target drops down in front of a transparent opening. With this arrangement, the only indicators exposed are those representing calls and as these are shown by figures against a white target they are easily read.

Another method is to expose a white target in front of a transparent opening, with the floor numbers painted in white above the openings for the targets. A Holtzer-Cabot Electric Co. annunciator of this type is shown in Fig. 8, and a drop with a reset coil is shown in Fig. 7. When coil *B* is energized by pressing a floor button, the lower end of armature *A* is attracted and the target is thrown to the right and is exposed under the floor number. When the reset button is pressed in the car, coil *C* is energized and the target is moved to the position shown in the figure.

Another system used in elevator annunciators is that of the Elevator Supplies Co., shown in Figs. 9 and 10. The floor numbers are painted in black on transparent glass, then when the white targets are exposed behind the glass the numbers show up clearly as indicated in Fig. 9. The *U* and *D*, indicating up and down direction respectively, have a white background painted on the glass behind the letters. In Fig. 8 the annunciator is arranged for mechanical reset by pushing up on the knobs shown extending below the lower end of the case, while in Fig. 9 the reset knobs are horizontal and are located just below the indicators. Fig. 10 shows the annunciator, Fig. 9, with the cover removed. The targets when not exposed are located on the left-hand side of the coils. When the coils are energized the targets are rotated through 90 deg. into the position shown on three of the coils. A push button for use with the annunciator, Fig. 9, is shown in Fig. 11 and a push button for a single bank annunciator is shown in Fig. 12.

Although mechanical resets are used extensively on elevator annunciators they have a number of objections. First, they are subjected to all the abuse that the operator may see fit to apply. They may be reset by an easy push of the hand or they may be struck a heavy blow according to the temper the operator may be in. Annunciators of the types shown in the figures are designed and constructed for the hard use they are subjected to in elevator service, and will stand reasonable usage. However, elevator operators and mechanics can devise many ways of breaking things if they feel in that state of mind.

Another objection to mechanical reset annunciators is that they must be located within easy reach of the operator. This is usually not the position where they can be most easily seen by the operator. The best position is generally on the opposite side of the car gate from the car switch. If a telephone is put on the elevator this should be near the operator and may interfere with the location of the annunciator, if this also has to be near the same location.

The electric-reset annunciator is coming into quite extensive use and eliminates some of the objections of the mechanical reset. On these types two coils are generally used on each drop, one to give the indication and the other to reset the drop. The reset coils on a single-bank annunciator are all connected in parallel and to a push button, as in Fig. 13, located in a convenient position for the operator. When the operator presses the button, all drops are reset. Up-and-down type annunciators have two reset buttons, one for the up bank of drops and one for the down. Such annunciators can be located in any position most easily observed by the operator; they are not subjected to the abuse of the mechanical reset type and are more quiet in their operation.

Electrical reset requires that both battery wires be brought to the car, but most annunciator cables are provided with an extra wire that can be used for this purpose. On some annunciators the bell or buzzer is not connected in series with the annunciator coils as in Figs.

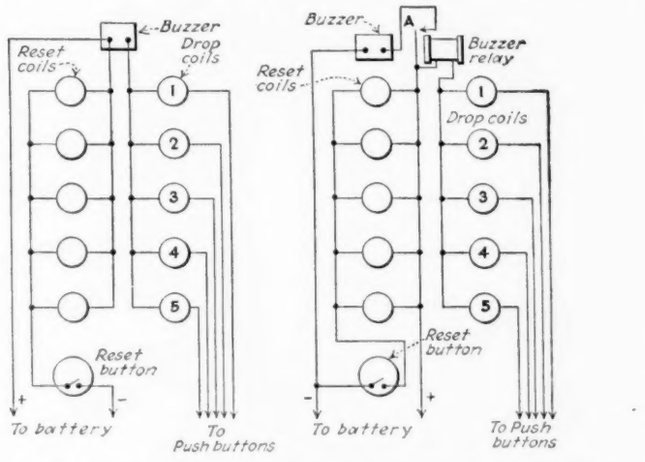
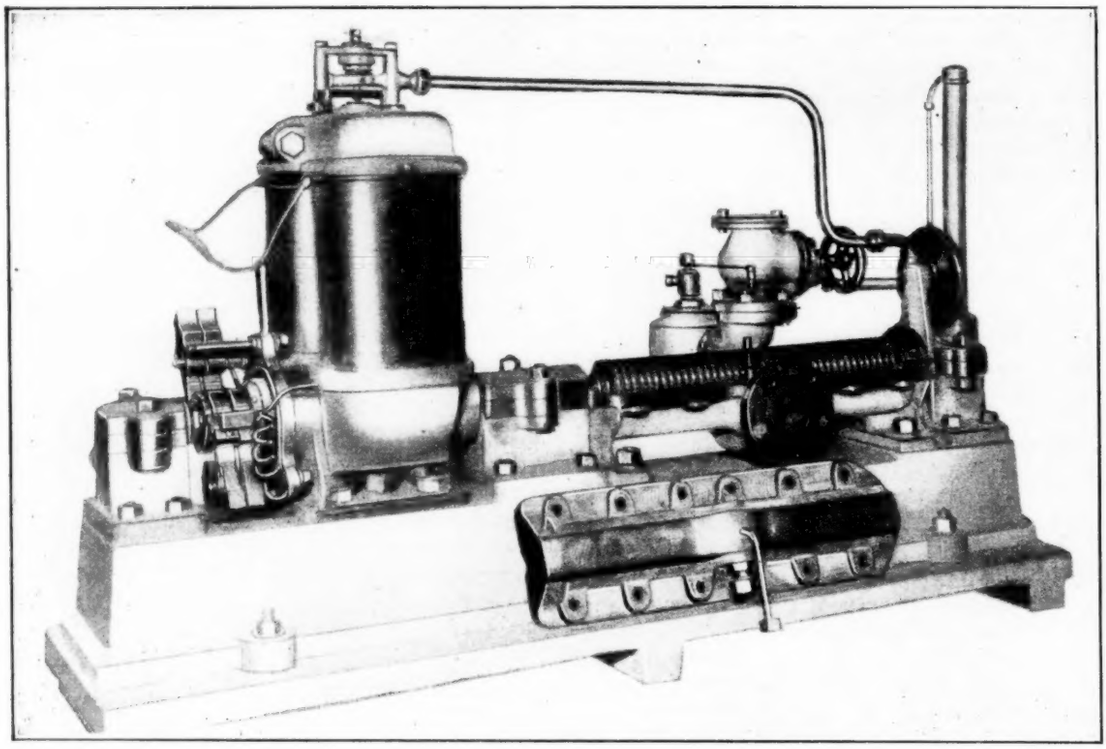


Fig. 13 (Left)—Diagram of single-bank annunciator with electrical reset coils. Fig. 14 (Right)—Diagram of single-bank annunciator with electrical reset coils and buzzer relay

2 and 3, but is connected to the contacts of a relay as in Fig. 14. This connection also requires that both battery wires be brought to the car and they can be used also for the electric reset. By putting in the relay as in Fig. 14, the buzzer is taken out of the drop-coil circuits entirely and the only make and break in these circuits is the push button.

In Fig. 14 if a floor button is pressed a circuit is completed from the + battery terminal through the relay coil, the drop coil and the push button that has been closed to the — side of the battery. The relay contact *A* closes and completes the buzzer circuit from the + to the — side of the battery. It does not make any difference whether contact A closes or not; the drop coils will be energized whenever the circuit is completed.

Individual-drop reset annunciators have been used to a limited extent. These require a push button in the car for each drop in the annunciator. Where it is desirable to have individual reset, automatic reset machines are generally installed and light annunciators of some type are used. These and other signal equipment will be treated in other articles.



One of the first Parsons turbines with generator

Some Notes on Steam Turbine Development

By W. J. A. London

I. Early Accomplishments—Work of Parsons, Stodola, Hodgkinson, Emmet and De Laval

THE history of the development of the steam turbine is one of the interesting pages in engineering accomplishment. Mr. London, with a background of wide experience, discusses, in this series of six articles, some of the outstanding features of this wonderful development. In the first article he describes the pioneer work of those men who made possible the turbine as we know it today.

IT IS with reluctance that one attempts, in these enlightened days, to write anything having the semblance of "A History of the Steam Turbine," but in these sketches the reader will be spared, at least, the exploits of Hero and his more or less visionary successors. Theoretical considerations, with regard to either steam performance or mechanical stresses, will not be taken up.

Contrary to the general rule of things mechanical theory has often followed practice in the development of the turbine. It was the overcoming of one difficulty after another that had, at the time of happening, no theoretical explanation, that taxed the ingenuity of the designer to the utmost, and it is with a few of these problems that this series of articles will deal.

The First Book

The first book on the steam turbine was published in 1902 by R. M. Neilson. It was quite a valuable book, considering the state of the art at that time, but gave little actual help to the designers of this new type of steam engine.

Stodola published the first edition of his notable book in German, in 1903, and this was of inestimable value. While theoretical in the extreme and with problems worked out with the thoroughness so typical of the con-

tinental scientist, it gave us our first published treatise on such subjects as the design of high-speed wheels, friction losses in disks and blades, nozzle proportions, etc.

While in no way belittling the value of Stodola's work, little of practical value could be learned from it of material assistance to the engineer in the design of a turbine, in general, and the details that go to make or break the successful commercial machine, in particular.

Early Development Work

With regard to the practical development of the steam turbine the pioneer work of Sir Charles Parsons naturally stands out as pre-eminent. This is only touched upon here in the order of events. It will be dealt with more fully later.

The actual "growing up" era of the turbine took place between the years 1899 and 1906, machines having increased in size during that period from 500 kw. to 10,000 kw. in a single unit.

It was during this period that the turbine designers received their hardest knocks. The demand for larger units was increasing by leaps and bounds, and at the same time temperatures and speeds were going up. Troubles were naturally experienced, many times of the most weird and (then) unfathomable nature, but it must be borne in mind that the designs of these larger machines were absolutely *NEW*. There were no precedents to work from, and what was acceptable practice in the smaller machines had, for obvious reasons, to be ignored.

Furthermore, these new machines were oftener than not sold before they were designed; so, when designed, they had to be built and work, and what is more, they *DID* work. (It was hardly practicable to build experimental 5,000-kw. machines and to test them under load.)

In the facing of the difficulties encountered during the evolutionary period referred to, the names of two men, Hodgkinson and Emmet, will go down in history. It was on the shoulders of these men that the brunt of the hardships fell, and to their indomitable courage and engineering ability, in often surmounting the insurmountable, is credit largely due for the possibility of the commercial 100,000-kw. machines of today.

In the many textbooks that have been written on the steam turbine, the larger part of the subject matter follows along the line of Stodola, supplemented according to the date of issue, with numerous illustrations of the general construction of the different classes of machines.

Although the theories and results of research work so published are essential to the work of the designer, the fact remains, nevertheless, that the majority of turbine breakdowns have been due to causes other than bursting wheels, excessive bearing pressures, or faulty nozzle or blade design.

It is no more than natural, therefore, that the reduction to actual *practice* of the excellent work done by the theorists had to be left to the *practical* engineer. More particularly does this refer to the design of the *stationary* elements, the importance of which, if accidents are to be averted, is equal to that of the rotating parts. Naturally, a great deal of study has been given to improvements tending to eliminate, even with the new high temperatures, the troubles that were frequent in the early designs. Such items as blade stripping in reaction machines is now an uncommon occurrence, whereas not so very many years ago this was accepted as a necessary evil, "an act of God," (or the devil). It was exceedingly hard to place the blame on the carelessness of the operator; consequently, in many cases the manufacturer was compelled to take the responsibility.

It is appropriate at this time again to refer briefly to the original work of Sir Charles Parsons. It must be borne in mind that up to his time no serious attempt had been made to develop, on a really practical basis, this unique form of prime mover. Of course history reveals innumerable patents taken out and suggestions made along the lines of a compound turbine, prior to Parsons' original patent, but owing either to the lack of enthusiasm with which these suggestions were received or to the obstacles apparent in the mechanical construction of such a device, or both, none of the schemes materialized. So the credit must be given to Parsons for facing and overcoming all the difficulties involved.

It was quite a number of years after the introduction of Parsons' first turbine that anything was really known of the theory of this machine, as we understand the term today, and practically every machine built in the earlier days had a different value for K, the coefficient used for the ratio of wheel to steam velocities.

It is interesting to review in a general way the progress that has been made, from a mechanical-design point of view, since the appearance of Parsons' first machine in 1884. With the knowledge that we now possess as to what is good and what is bad design, we are inclined to be supercritical of the earlier designers and wonder why, in many cases, they did not know better. It must be pointed out, however, that we must not be too rash in our criticisms, many of the devices designed by the pioneers of the steam turbine showing an ingenuity that present-day designers would be proud to possess.

Considering the state of the art at that time, the mechanical problems that faced the inventor were of no mean order—not so much in the turbine itself, as this turned out to be the simplest part of the proposition, but a turbine was of little use without something it could drive for doing useful work, and of course a reliable controlling mechanism was an absolute essential.

The unit, therefore, taken as a whole, consisting of turbine, generator, governor, flexible bearings and oiling mechanism, was an outstanding example of exceptional ingenuity of design.

About 1887 Dr. Gustav De Laval developed his first turbine for mechanical drive, and his name will also go down in the history as one of the great pioneers of turbine engineering.

He approached the problem from an angle different from that of Parsons, in that he built his machine on the Ideal turbine principle, using only one wheel to absorb all the energy of the steam. This brought his turbine up to speeds of 30,000 r.p.m. De Laval deserves special credit for downright courage and exceptional engineering skill. His appreciation of the necessity of a flexible shaft, his introduction of high-speed double-helical gearing, now so universally adopted, and his knowledge of the proper design of high-speed wheels, the contour of which has changed but little through all the scientific investigations that have been made up to date, deserve special attention. In addition, the introduction of the helical gearing by De Laval was a happy solution to many of the difficulties encountered by Parsons.

In following the development of the two types of machines, it is seen that the De Laval machine has been confined to comparatively small sizes, whereas the Parsons type has grown to stupendous proportions without material change from the original principle.

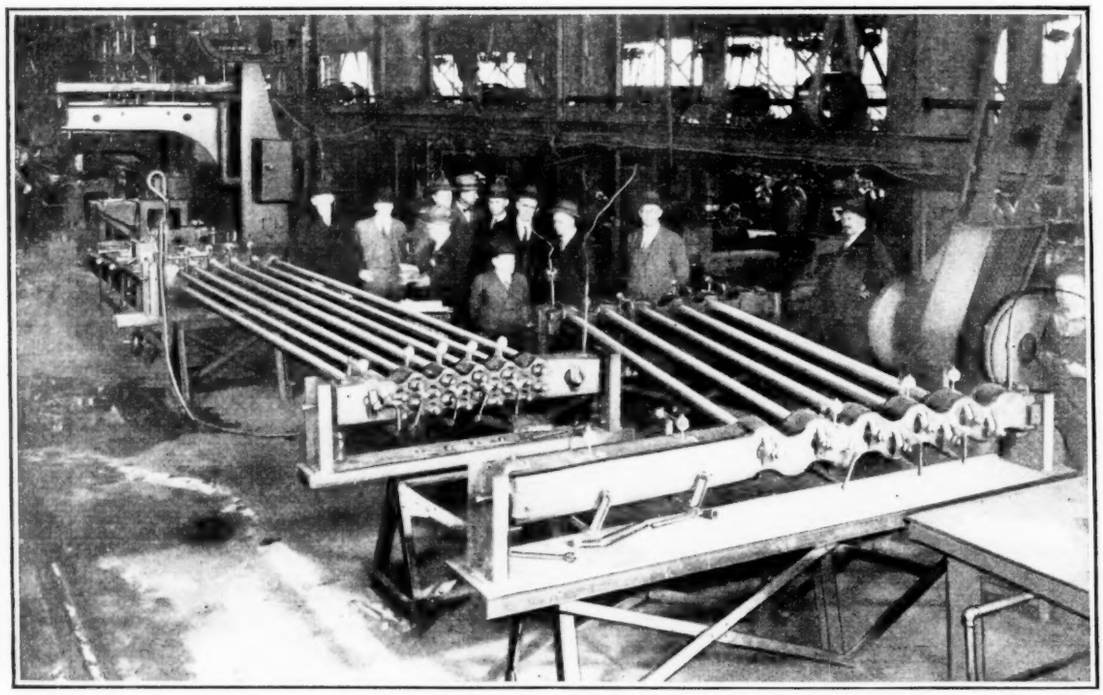


Fig. 1—Set-up for hydrostatic tests on the Edgar boiler headers

Hydrostatic Tests Determine Boiler Working Pressure

THE Massachusetts Board of Boiler Rules when called upon to approve the design of the 1,400-lb. boilers for the extension to the Edgar Station of the Boston Edison Co., desired hydrostatic tests to be made on representative sections of the boiler in order that the allowable working pressure in the boiler headers might be determined. This was considered necessary because of the complexity of the calculations for figuring the stresses existing in the header sections and the excessively high pressures involved.

The tests as made at the shops of the Babcock & Wilcox Co. followed the methods proposed by a special sub-committee of the A.S.M.E. Boiler Code Committee. The consistent results secured from these tests indicate the practical worth of these proposed methods, which were published in the August issue of *Mechanical Engineering*.

An inclined upper deck section, a vertical lower deck section, and a junction box were submitted to the hydrostatic tests and are shown ready for testing in Fig. 1.

Each section was subjected to repeated applications of progressively higher hydrostatic pressure. In each case, total deformation was measured with the pressure on, and after each such observation the pressure was released and measurements were made to determine permanent deformation, if any.

The pressure was increased by equal increments up to 3,900 lb. per sq.in. At most of the stations the proportional limit was obviously exceeded by this pressure, but at some of the stronger sections the stresses produced were still below the proportional limit.

The deformations were measured with an Ames gage that was clamped between a "C"-shaped member and the header. The "C"-shaped member was made from angle iron welded together, one end of the "C" being welded to the header. The Ames gage indicated the total deformation, that is, the sum of the deformation of two sides of the header. The location of the various stations at which measurements were taken may be seen in Fig. 1.

For each station or measuring point, two curves were plotted with hydrostatic pressure as ordinates, one showing the total deformities under pressure, and the other showing the permanent deformation when the pressure was removed. Fig. 2 is a sample of the curves obtained.

A straight line is drawn through the average of the points that lie approximately in a straight line on the curve of total deformation. The proportional limit occurs at the hydrostatic pressure where the curve through the points deviates from this straight line. It will be seen that this point is checked closely by the point at which appreciable permanent deformation starts. Small permanent deformations that occur prior to the point of pro-

portional limit, caused by irregularities in the material, may be disregarded.

For each header the average hydrostatic pressure corresponding to the proportional limit of similar points at the weakest sections of the header was determined. The maximum allowable pressure was calculated by dividing the average hydrostatic pressure at the proportional limit by two. A summary of the results obtained is given in the table. The allowable working pressure determined as above is referred to as method B.

The working pressure may also be determined from the following formula:

$$P = \frac{H \times S}{5\,E} \text{ (method A)}$$

where P is the maximum allowable working pressure, H the hydrostatic pressure at the proportional limit, S the average tensile strength of the material, E the average proportional limit of the material.

The tensile strength and proportional limit of the material was determined by tensile test of coupons taken from the header. Several specimens of the material were taken from the ends of the header before it was machined. Additional test coupons were taken after the hydrostatic tests had been performed. The average of the results of these physical tests is included in the table.

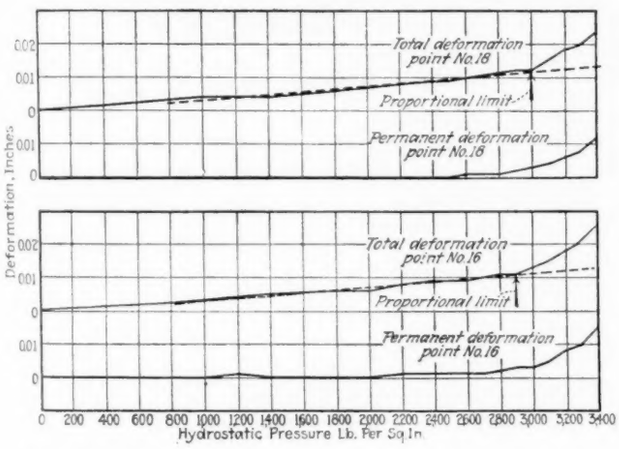


Fig. 2—Stress strain curves plotted from results of hydrostatic tests

The results of these tests indicate that the inclined headers for the Edgar boilers are good for a maximum allowable working pressure of 1,466 lb. per sq.in., that the vertical headers are good for a maximum allowable working pressure of 1,766 lb. per sq.in., and the junction box for 1,675 lb. per sq.in.

MAXIMUM ALLOWABLE WORKING PRESSURES BASED UPON HYDROSTATIC TESTS

Header Number	Hydrostatic Pressure at Proportional Limit	Proportional Limit of Metal	Tensile Strength of Metal	Maximum Allowable Working Pressure Method A	Method B
3	2,933	17,738	50,810	1,678	1,466
4	2,960	21,083	50,583	1,421	1,480
5	3,900	23,960	55,930	1,820	1,950
6	3,533	20,480	50,160	1,730	1,766
Junction Box	3,350	23,250	51,200	1,475	1,675

As a result of these tests, the Massachusetts Board of Boiler Rules has passed the Edgar boilers allowing a maximum working pressure of 1,400 lb. per sq.in. Pressure parts other than the headers were found to be the limiting factor.

It is expected that these boilers will be put in operation within the next few months.

What Do You Know?

The answers are on page 331

PRACTICALLY every power plant has a boiler, and engineers should know boilers. Here are 10 questions dealing with the boiler plant alone, some easy to answer and some not so simple, as the editor found. You should answer nine if you are qualified to hold a first-class license. If you register less maybe movies should be cut out for a few weeks and the engineering section of the brain overhauled. At times one differs with even the Ouija board, so if you find yourself out of harmony with the editor's answers send in your challenge.

Ques. 1—What is a dry-back boiler?

Ques. 2—Why do the corrugations of the furnace of an internally fired boiler run circumferentially instead of longitudinally?

Ques. 3—In figuring the cost of power generated by a non-condensing engine, where all the exhaust is used in manufacturing processes, how should the ratio of cost of steam be figured when credit is given to the heat in the returned condensate?

Ques. 4—What produces draft in a chimney, and what does the amount of draft depend upon?

Ques. 5—Should the ends of new boiler tubes be annealed before being expanded.

Ques. 6—How would you "fall" a brick chimney 6x6 ft. at the base, and 65 ft. high?

Ques. 7—What is the nominal evaporation per hr. per sq.ft. of heating surface of a boiler?

Ques. 8—What does the existence of *CO* in the flue gases indicate?

Ques. 9—What is meant by *proximate* analyses of a coal?

Ques. 10—If the lower manhole in a horizontal tubular boiler is leaking at the joint, is it advisable to tighten up on the yoke-bolt nut in the effort to stop the leak?

Where *do the* Pipe Lines Run?

By W. Edward

THIS article is the first of a series that relates how an engineer in charge of the heating system of an industrial plant found out why his system gave trouble, and how he corrected it.

Ever see sparks on a heating system? We have, usually on the first cold day in the Fall. They originate in the manager's office, coincident with his turning on the radiator valve. Radiator hammers! Joints leak! Floor gets flooded! Telephone call to us in the engineering department!—sparks! The heating season is thus officially opened.

But, as a rule, sparks on a heating system are an indication of conditions that should not exist. The heating season should officially start some weeks ahead of the first cold days. Ours does now, thanks to the help we secured to point out and eliminate our trouble. Perhaps our telling about it here will do some good. We'll start with the last time we saw, or heard, the sparks:

Briefly, our source of heat is obtained from four main boilers of about 2,500 square feet each, operated at 100 lb. pressure. The steam is used by a steam hammer, an air compressor, a pair of pickling hoists, and is sent for heating purposes to the plant through reducing valves at various points on the steam power mains.

The plant includes five main groups of buildings set on a plot that measures approximately 1,200 x 500 ft. The power house is located about centrally as to length of the plot and to one side. The buildings can be sketchily described as follows:

One 600 x 150-ft. factory building of steel and glass construction, provided with two unit blowers for heating.

One 500 x 150-ft. building of the same type, with five smaller unit blowers located in the roof trusses.

One 150 x 60-ft. two-story building of brick and steel sash construction with direct heat.

One 200 x 60-ft. four-story building of brick and steel sash with direct heat.

One group of five old-style buildings, brick construction common center walls, wood roof, square skylights, measuring together some 200 ft. square and also provided with direct heat.

In this latter group were the offices, and most of our trouble. The plant as a whole is more or less of a mushroom growth as business of the moment had demanded. The heating system is ultra-mushroom, a typical unguided pipe fitter's product. And yet not so different from many we had seen in the plants of our friends.

Each season we, in the engineering department, were ready for action in plenty of time ahead of the first cold day. We mended and patched, added to and took away, but we were never quite able to catch up, as it was difficult to obtain appropriations from our management prior to his feeling the bite of frost. Then, when we finally heard the sparks, and figuratively saw them, we had to place rush orders and work overtime, which is not conducive to either economy or results.

Authorities on heating had been consulted, but they usually wound up with a long list of equipment to be bought all at one time, a thing we could not consider. One day a friend told us of another source for engineering service. We were skeptical by this time, but we called up as directed and presently a representative of the company appeared.

We took him to our office and waited to see what kind of nickel-plated gadgets he had for sale. He had a bag, a sizeable one, but to our surprise all he produced from it was a book and a suit of overalls.

"Why the overalls?" we asked him.

"Well," he said, "I want to spend a couple of days checking over your system. It will probably require overalls, for I work where the heating system is. Desk heating counsel is not worth much unless you know where the pipe lines run, and how they run, and what is connected to them. Happen to have a system layout in your files?"

"No," we told him, "but we'll turn the heat on if you wish, so you can trace it by the leaks. That's our method."

"It's the method in many places. Ever make a pipe line layout?"

"Yes, we've done that too, but it does no good. It takes weeks, a bunch of draftsmen and a lot of ink. Then, when it's all done it doesn't mean anything because the pipe fitters will have changed it in the meantime."

"There's your first trouble," he replied, "and your first job, for we must have that layout. No, now don't look disappointed. It's really simple, as I'll show you with the help of the data book I have brought along. First, let me tell you why we must have it. You can buy traps and strainers and all the other things you may need, but they are of no use if the steam cannot get to them.

"The first step in a survey of any heating system is to find out and correct the many little troubles that cause most of the fuss and cost only labor to eliminate. Thus one of the reasons I am here is to give my company's equipment a chance to perform. Most of the industrial plants are under-equipped, and there is a worth-while market for us, but we do not desire to sell our units until we know they will do some good."

"But," we said, "suppose we do need a lot of equipment. It will run into so much money at one time that we'll never get the appropriation through. There is where all of our past experiences with you chaps have wound up, except that no one ever told us before that there might be things in our heating system that we could correct."

"No fear of that in this case," he reassured us. "We know that danger to you as well as to ourselves. First, we will locate your major system troubles. They can be handled at practically no expense. Then, with your system functioning, we will lay out a program of im-

provement that can be spread as thinly as you wish. There's just one more point.

"I do not hold you to buy our product just because I am here to help you out. I want you to consider my offerings in fair competition with others for like purposes. I am content to have an even show. Are you ready to go?"

"You lead the way," we told him. We felt—yes, we knew that finally we were on the way to a solution of our heating problems.

"All right," he said, "I'll first show you how to make your layout. Then, while you are at it, I'll scout around the plant. Here is a set of symbols that I have gathered together. You can use them as they are or alter them to suit yourselves. They follow those given partly in Kent, and are convenient when applied to your plant floor plans. I suppose you have such floor plans." We drew ours out of the file, but still were a bit skeptical as to whether the job could be done as easily as he said, and told him so.

"Here, let me give you a bit of instruction. Over there on the wall is a reducing valve and its bypass. We'll sketch it in plan. I prefer to use the plan idea rather than elevation, and one gets badly mixed if he tries to show both. In this way elevations are shown as interrupted sections and are keyed to the plan. Now, watch while I make a sketch. Then, I will explain it—there, that took about thirty seconds. I have spread it out larger than is really necessary in order to help you understand at the start.

"Read from right to left. There's a 1½-in. covered line coming through the bypass tee, and a line valve to the reducer. The tee and the valve have single indicating lines and are, therefore, screwed fittings. The reducer is supplied, as shown, with unions. The line passes through the reducer and does not change size until it has passed through two short nipples and a valve to the flanged tee. This tee is 4 in., meaning that there is a

FITTINGS	VALVES	EQUIPMENT
Elbow	Check	Strainer
Tee	Line	Lift fitting
Union	Quickacting	Bucket trap
Bushing	Reducing	Radiator trap
Flanges	Diaphram	Expansion joint
Cap	Non return	Separator
Elbow looking up	Relief	Return bend coil
Elbow looking down	Needle	Cast radiator
Tee looking up	Cock	Pipe radiator showing feet of radiation
Tee looking down	Float	Pressure gage
Flanged ell	Angle	Thermometer
Flanged tee	Foot	Flow meter

Fig. 1—Symbols for use in making pipe line sketches

reducing flange on the reducer valve side. That completes the run of the line as I have sketched it.

"From the screwed tee on the high pressure side, we run through an elbow, another line valve, a tee looking up, another valve and another elbow to the 4-in. flanged tee again. The tee looking up we mark *A* and draw a vertical section to one side, as I have also shown, starting with this tee. This section indicates a ¼-in. bushing in the tee, a cock and a pressure gage. You will note now several important points.

"The size of line and the fact that it is covered is noted at the start of your sketch. This size notation is not repeated until there is a change, as at the 4-in. flanged tee or at the small line going to the gage.

"I've guessed at your pressure reduction and noted it on the reducing valve.

"It is not of particular import to know if a valve is a gate or a globe design and how its stem faces. It is very important to note the position of flanges, unions, plugged tees or capped pipes so you can know where lines may be taken apart and extensions added.

"We will not discuss pipe sizes now. That will follow when we know present conditions. I want to say about valves, however, that apparently you are not afraid to use enough of them to make a good flexible job. Many engineers stint on valves and lose a lot by so doing. With the arrangement as you have it here, you can bypass steam while you are working on or replacing the reducer. That's a real advantage in emergency. And your bypass

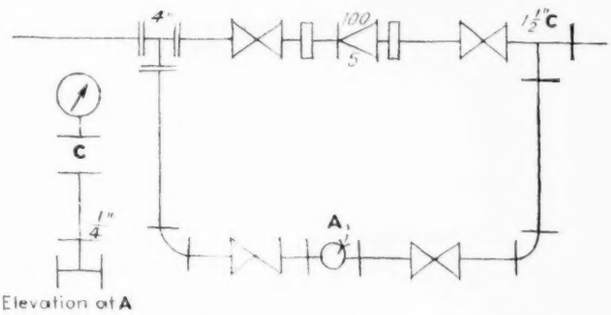


Fig. 2—Sketch illustrating use of symbols

runs horizontally, as it should, instead of below the reducer to block it off for bottom dismantling.

"While this particular sketch does not show it, there are often two, or even three, lines running one under another through the plant. When that's the case, I usually offset them and show them on the same plan, unless they are very complicated. Then, I use two plans, or more, with the proper connection notations.

"It is unnecessary to put down all details at points where you can standardize construction. At reducing valves, for example, or at pipe coil radiator connections, etc. Here in my data book are a number of such standards suggested. Now, you get to work on the layout while I go through the shop."

We had been watching closely and listening carefully. Could we do the sketching? It certainly looked very simple, and, as we found after a little practice, it actually was as simple as it looked.

We provided a guide from the pipe-fitter gang, and our visitor departed, while we began to dig through his data book and learn how to make a pipe line layout.

He spent the day in the plant, and then left until our layout would be finished. Three days, it took us. Then, we called him, and he returned to check up with us.

And the things we found—but that's another part of the story.

COMMERCIAL COOKING PRESENTS to the power company a wide and varied field. Most power company executives realize the desirability of this load, but very few appreciate its present magnitude. In 1926 the consumption for this load was 43,495,314 kw.-hr., or approximately 3,625,000 kw.-hr. per month, nearly 160 kw.-hr. per month for each kw. connected load.—*Serial Report of the Commercial Cooking Committee, N.E.L.A.*

Alignment Chart for*

Heat Loss in Flue Gas

C. ALBERT KULMANN
Consulting Engineer, Palo Alto, Cal.

THE CHART for determining the heat loss in flue gas is based upon the formula generally used for calculating the heat loss in dry flue gas:

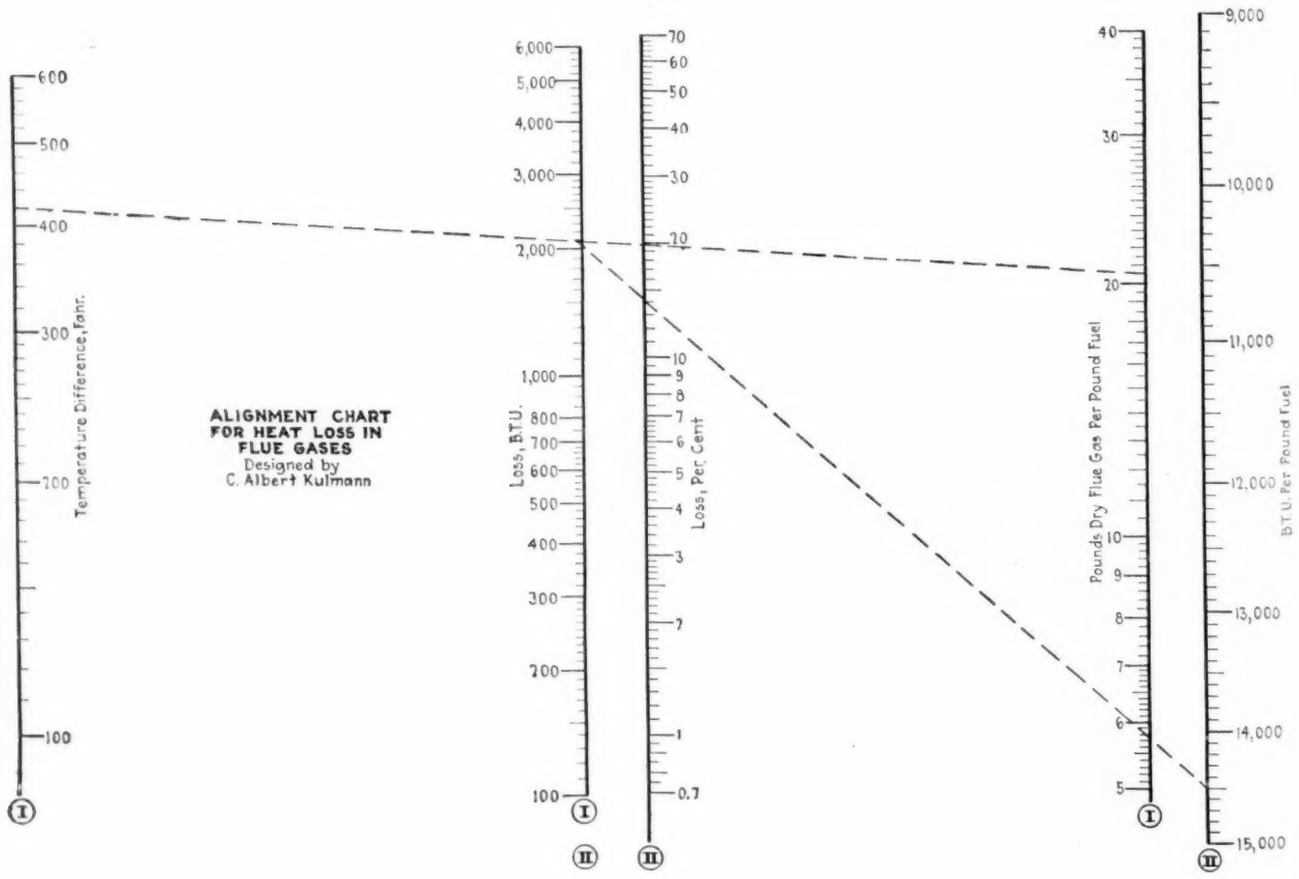
$$\text{Heat loss in B.t.u.} = 0.24\, W_o(t - t_o)$$

$$\text{Per cent Heat loss} = \frac{0.24\, W_o(t - t_o)}{H}$$

in which W_o = weight of dry gas per pound of fuel,
t = flue gas temperature in degrees F.,
t_o = room temperature in degrees F.,
H = heat value of pound of fuel.

In using the chart, the point representing the proper value of the weight of flue gas per pound of fuel is connected to the point representing the proper value of the temperature difference (difference between room and stack temperatures). The heat loss in T.t.u. per pound is represented by the point where this line crosses the loss-B.t.u. axis. By connecting the point so determined with the proper point representing the heating value of the fuel on the B.t.u. per pound fuel axis, the percent heat loss can be read on the proper axis.

To illustrate the use of the chart the following data will be assumed; 20.5 lb. of gass per pound of fuel, 490 deg. F. gas temperature, 70 deg. F. room temperature, and coal having a heating value of 14,500 B.t.u. The line drawn from the point 20.5 on the right-hand scale to the point 490—70 or 420 deg. F. on the left-hand scale intersects the heat-loss scale at 2,060 B.t.u. The line from this point to the point on the right scale representing the heating value of 14,500 B.t.u. intersects the per cent scale at 14 per cent.



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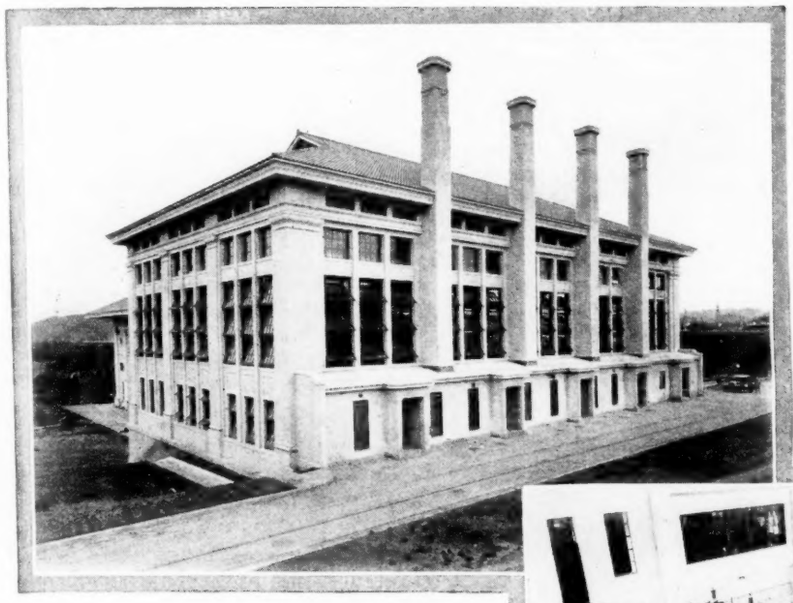
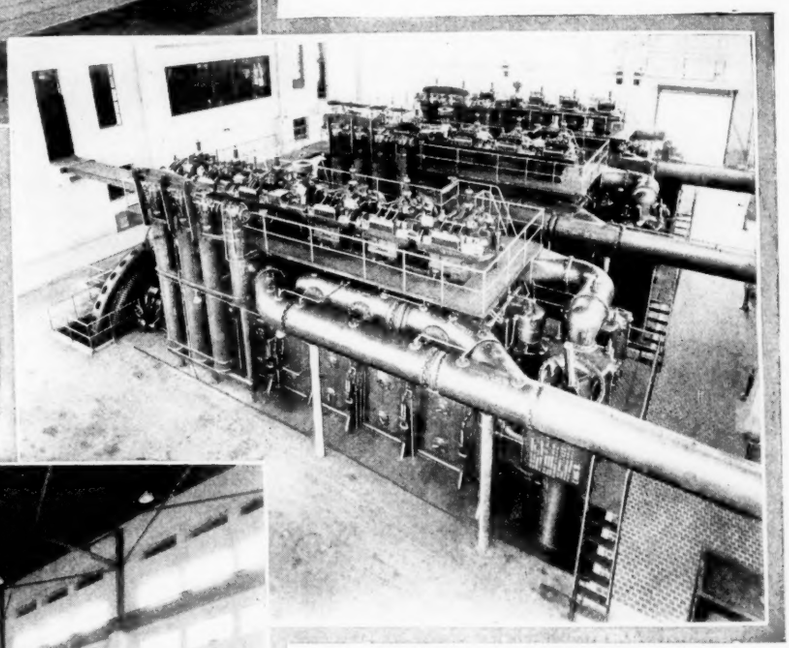
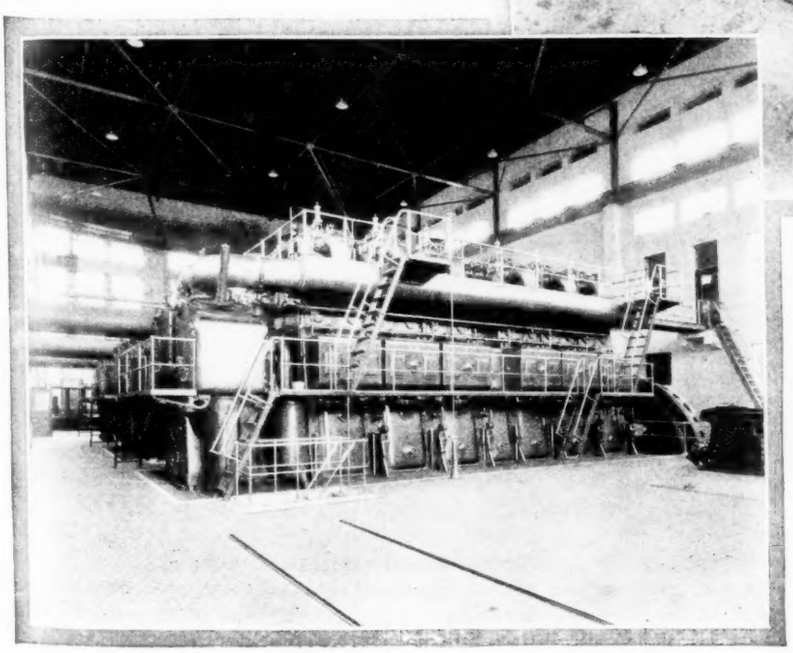
New Standby Diesel Engine Station for Panama Canal Locks



Left—A new 11,250-hp. Diesel electric plant located at Miraflores, Canal Zone, supplements the present hydroelectric plant at the Gatun Spillway. The building, of steel frame and concrete construction, has an inside floor space of 78 ft. x 135 ft. Each unit has a separate exhaust stack and muffler. Large windows afford ample light.



Below—Interior view; here is shown one of the two air pumps at the rear of No. 3 engine. The scavenging air duct leading from it can be plainly seen at the top.



Above—View of the engine room showing the three 3,750-hp. Diesel units now installed. The valve mechanisms and operating platforms may be plainly seen, with starting air bottles and exhaust headers in the foreground.

Electric Signal Systems in Central Stations

By E. H. Stivender

TEN years ago, when the term "engine room" in a power plant was confined to the site of the prime movers and the switchboard was as conveniently near the units as possible, there was no need of electric signals. In most cases the switchboard operator was also the steam engineer, and when difficulty was encountered with any equipment, either electrical or mechanical, he was on hand to attend to the trouble. But in modern times, when plants of 200,000 kw. are common and all switching and synchronizing are done electrically, the switchboard is often distant from the prime movers and the switchboard operator and turbine engineer must communicate in a simple and intelligible manner as rapidly as possible. The loss of time in cases of trouble is a serious matter.

In addition to communication between the turbine room and control room in steam plants the network often includes signal systems for the boiler room and condenser pit. An elaborate and rapid communication system is

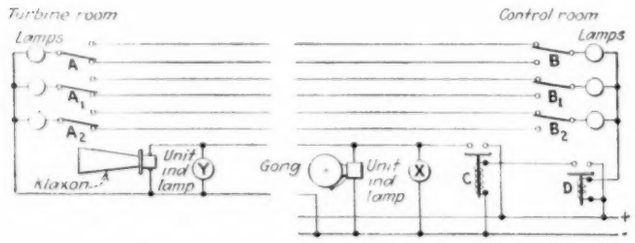


Fig. 1—Two-way pushbutton signal system

thus formed, and it could not be replaced with telephone service except with the use of loud speakers. In that case there is much danger of misinterpretation, as the ear is not so reliable as the eye, especially in exciting moments.

Not only have manually operated electric signals appeared with the development of superpower stations, but there have also been many automatic alarms and indicators developed, such as governor primary, secondary and tertiary valve-operation indicators; governor control-spring tension indicators; temperature alarms for bearings, generator windings and transformer windings; alarms for incorrect circulation of transformer cooling water; and various signals and alarms to indicate circuit-breaker operation. These all terminate in the control room, the degree of their prominence being determined by the importance of the condition they indicate.

The most practical alarms for the control room are buzzers or gongs. A gong is generally used for manual signaling, although a lamp sometimes replaces it. The two are often combined so a gong will sound to attract the operator's attention, while a lamp indicates the section of the switching system at which his services are needed. For automatic trouble alarms a continuous bell rings, sometimes operated from a centrally located annunciator and sometimes directly from the circuit breaker through its control panel. The ringing is stopped by either resetting the annunciator or operating a push button or control switch on the circuit-breaker control panel. In some types which are coming into more general use, the green-lamp circuit of the circuit breaker is opened by hand after the switch has been tripped, so that when any other breakers trip automatically, their location can be readily determined by the only green lights showing when the alarm sounds. (It will be noted that a few installations call for a red lamp to indicate the circuit breaker open, this practice being based on the argument that a red light in a group of green ones is more discernible than a green light in a group of red.) The practice of disconnecting the open-breaker indicating lamp is not only helpful in trouble, but is more

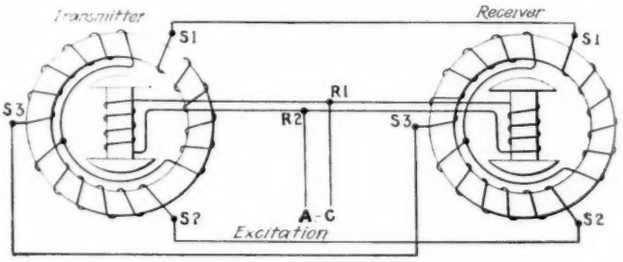


Fig. 2—Connections of selsyn signal system with single-phase excitation

economical, as switchboard lamps use up to 15 watts each and in large plants will use an appreciable quantity of direct current.

In turbine rooms, where noise is always prevalent, a klaxon or a siren is employed as an alarm, but in some cases a group of powerful lights attracts the engineer's attention. Some condenser pits have low ceilings which contribute to a noisy room, and the usual resort is to install large indicating lamps throughout. Klaxons or gongs are sufficient for boiler-room alarms. For drawing attention to the proper unit in the generator room, a group of large lamps at the end of the room, numbered in accordance with the numbers of the units, is sometimes employed, while in other cases an indicating

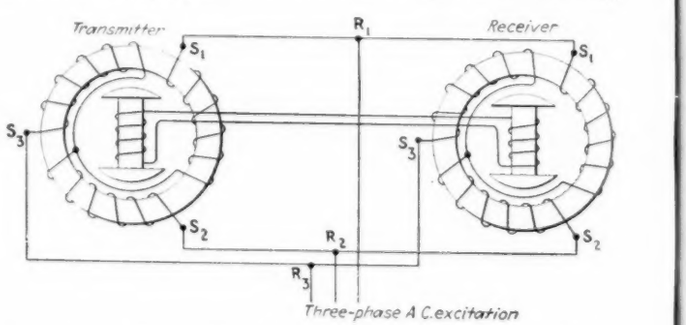


Fig. 3—Similar to Fig. 2, but with three-phase excitation

lamp at each unit is found more desirable. Each operating panel or signal stand is near its corresponding unit.

There are a number of signal systems which differ electrically, but the two shown in the figures combine the essentials of most modern installations. Figs. 2 and 3 refer to substantially the same system. That of Fig. 1 employs push buttons, each of which is marked for a particular order or message, and operates a small lettered lamp at the other stations to be communicated with. In Figs. 2 and 3 the operator rotates an arm over a lettered dial which transmits the message by means of a similarly lettered dial at the opposite end.

Two-way push buttons, *A* and *B* in Fig. 1, close the circuit through their respective indicating lamps and through the sensitive relay *D*, which is in series. It operates the heavier alarm operating relay *C*, which energizes the gong in the control room and the klaxon in the turbine room, together with their unit-indicating lamps *X* and *Y*. The operator at the receiving end then presses the push button corresponding to the circuit indicated, which de-energizes the lamp at each end, indicating that the message was received.

In the system of Figs. 2 and 3 there is a central signal stand in the control room and individual signal stands are placed in the generator room. The control-room operator turns a drum switch to cut into circuit the signal station desired, then transmits the message by turning the indicating-dial arm. There is a duplicate dial in the control room with which the other operator verifies the message or signals back. To simplify the diagram, the illustrations do not show the drum swich, the duplicate dial in the control room, nor the sending dial in the turbine room. The elements of this system are all alike electrically; that is, the hand-controlled instrument is of the same internal construction as the one at the receiving end.

Fig. 2 operates on the principle of the selsyn. (See *Power*, page 950, June 21, 1927). The instruments are small self-synchronizing motors, similar in appearance to three-phase induction motors and having shuttle-wound single-phase rotors with definite poles. The fields are connected together as shown, and the rotors energized through slip rings from a single-phase source. In operation, if one rotor is held in any position, the other tends to take up a corresponding position. The voltages induced in the different phases of the field windings by either rotor are unequal and vary with its position. If the two rotors are not in corresponding positions, a current will flow in the field circuit which will exert a force on the rotors, forcing them to those positions. For instance, in Fig. 2 assume the transmitter rotor to be in the position shown. As the stator winding is three-phase and the rotor single-phase, the voltages induced in the stator winding will be unbalanced. Since the transmitter and receiver are similar, if the receiver rotor is also in the position shown the voltages induced in its stator are identical with those of the transmitter, and they balance each other. If, however, the transmitter rotor is moved to another position and held there, the stator voltages shift accordingly. A current is thus caused to flow in the stator circuits which tends to force the receiver rotor to a position corresponding to the transmitter rotor, where no current will flow.

The system of Fig. 3 is similar except that the fields are excited with three-phase alternating current. If the rotors are not in corresponding positions, the voltages induced in them are out of phase, and a current flows which tends to force them to the same position. A modified potential-field three-phase power-factor meter is sometimes used as the receiver unit on such a system, as the principle of operation is essentially the same. A small motor with a three-phase stator and a single-phase rotor serves as a transmitter. These systems are often used to actuate remotely controlled indicators of rheostat-arm or governor-spring positions, as the exact corresponding setting will be shown at all times.

As an operating point it is well to mention that all signal systems should be checked with every change of shift to insure against trouble from faulty contacts, burned-out lamps or other minor defects.

Answers to What Do You Know

The questions are on page 325

Ans. 1—An internally fired boiler having a rear head formed by the tube sheet and which has no water space at the rear of the tube sheet, the combustion chamber being brick lined.

Ans. 2—If the corrugations ran longitudinally, the furnace would tend to collapse due to the external water pressure. Furthermore no means of caring for the lengthwise expansion would exist.

Ans. 3—If the total cost of steam generated be represented by the B.t.u. in the steam generated minus B.t.u. in the condensate the ratio of the cost of the heat used for power to the total cost of generating the steam would be:

$$R = \frac{2{,}415 \times (hp.\text{-}hr.\ developed)}{(B.t.u.\ in\ steam) - (B.t.u.\ in\ condensate)}$$

This is for the reason that an engine actually removes but 2,415 B.t.u. per hp.-hr. from the steam, neglecting the very minor radiation losses.

Ans. 4—The draft is caused by the difference in density of the gas inside the chimney and the outside air, and a high gas temperature or a tall chimney will increase the pressure difference and the gas velocity.

Ans. 5—Modern boiler tubes are made of mild steel and are properly annealed at the steel mill before shipment.

Ans. 6—One method is as follows: About 4 ft. from the base at a point opposite the side toward which it is desired to have the chimney fall, cut a mortar joint clear through the wall and lining, and drive into the point 10 or more steel wedges. Next cut through the adjoining side walls and finally on the side toward which the chimney is to fall, make an opening about 3 ft. high. Now, alternately pick away the adjacent sides and drive in the wedges until the chimney topples.

Ans. 7—Most boilers are rated to evaporate 3.4 lb. from water at 212 deg. F. to steam at the same temperature per sq.ft. of heating surface.

Ans. 8—While experiments have shown that *CO* may be present even with large amounts of excess air, it ordinarily occurs in noticeable amounts only when the excess air is low. So, in general, if we start with a large amount of excess air and begin to cut it down by stopping leaks and by better firing and draft control, the chimney losses decrease until the point is reached where *CO* begins to form in appreciable amounts. If the air is still further reduced, the chimney loss will increase again due to *CO*. It can easily be figured that 1 or 2 per cent of *CO* represents a large loss. The actual loss will be greater than that figured, because *CO* indicates the presence of other unburned gases that do not appear in the flue-gas analysis. The aim in practice should be to keep the CO_2 as high as it can be kept without danger of getting appreciable quantities of *CO*.

Ans. 9—An analysis of coal giving the percentages of moisture, volatile, fixed carbon and ash is called a *proximate* (*not approximate*) analysis, as distinguished from an *ultimate* analysis that gives the percentages of the various chemical elements, carbon, oxygen, hydrogen, etc. The former type of analysis is much easier to make.

Ans. 10—The total area of a standard manhole cover is about 130 sq.in., which with 100 lb. boiler pressure gives a total of 13,000 lb. forcing the cover against the gaskets. If this will not stop the leak no tightening of the bolt will be of assistance.

EDITORIALS

F. R. LOW, *Editor*

Go Over the Piping

PIPING arrangement is an old story, but one that will bear repeating, and in this issue is the first of two or three articles telling how one man was able to make his heating system work better than ever before by an intelligent and systematic study of the layout. His method was simple. No drafting board or scale drawings. Just sketches that anybody can make with little or no practice.

The engineer who is responsible for a heating system, or for any other kind of system, for that matter, will do well to study this man's method and adapt it to his own needs. It is a great thing to go over the old familiar ground putting things down on paper exactly as they are. Many an engineer could sit at home and make up a sketch of his plant piping from memory, but it is dollars to doughnuts that a comparison of his sketch with his plant would reveal many an interesting discrepancy.

Because of this too easy tendency to put things down as we believe them to be, or as we know they should be, it is sometimes a good plan to have a layout of things as they are made up by a man new to the plant. Not only will his results be more likely to agree with the facts, but also he will thereby acquire a useful familiarity with the equipment in all its details, and, since questions must be asked, he will come to know many of the older men.

And the arguments that will arise! Why does hot water go to the sewer, or cold water to the hot tank? Why is there a section of two-inch pipe in the middle of a four-inch run? Why is a check valve in backward? The old man in the plant is likely to overlook such things because he just knows there aren't any such ridiculous things in his plant. The new man, who doesn't know so many things that aren't so, sees with his eyes rather than his wishes or his memory, and may uncover many a source of bad operation.

Going over the entire piping system will pay well.

Vacuum Tubes

THREE-ELECTRODE vacuum tubes have been responsible for many accomplishments in science during the last few years. Although first applied to radio communication, and developed principally for that purpose, they are rapidly finding applications in other fields. They are powerful amplifiers of very weak currents, and by virtue of this property can be used as sensitive relays in signal and control circuits. Moreover, their action is instantaneous. As oscillators, or generators of high-frequency alternating current, they are also used to supply power to these signal circuits.

As a direct outgrowth of radio communication, high- and medium-frequency carrier-current communication have been developed to a reliable state for signaling and remote control over transmission lines. High-frequency current generated by vacuum tubes is impressed on the existing power lines and received at another point through selective circuits, by means of receiving tubes, to operate control equipment or signals. Only terminal apparatus is thus necessary, and the normal power service is not interfered with.

Demonstrating the refinements in remote control made possible by vacuum tubes, Judge Gary recently set a steel mill in operation by moving his hand toward a sphere on an office desk. Vacuum tubes acting as extremely sensitive relays operated heavy control circuits which started the distant mill. While such a method is not soon likely to become common practice in starting steel mills, it does show the remarkable performance which may be obtained from such circuits. These same properties of vacuum tubes and their circuits are now being applied to sensitive indicating and measuring devices, not only for precision work in laboratories, but also in every-day factory production.

Appearance on the market recently of a vacuum-tube synchroscope shows another application. Tubes are here used to actuate an indicator similar to that on a synchroscope of the ordinary type. Thus an old standard type of instrument is seen to be replaced by the more modern method, which is a convincing indication of the practicability of tubes for rigorous and reliable everyday use.

Until very recently, vacuum tubes have been regarded as only applicable to laboratory work or to somewhat uncertain performance in radio and long-distance telephone communication. However, their increasing value in numerous fields is becoming evident and cannot longer be overlooked in the power field. Their development has been rather phenomenal, and many practical men have quite naturally not followed it. But the working examples of their value must not be disregarded, for it is fairly certain that the surface is hardly scratched.

Water Glands for Steam Turbines

EARLY American steam turbines used various forms of steam packing at the glands where the shaft passed out of the casing. Some of these were of the carbon-ring type and others of labyrinth type. Several makes of turbines still use these forms of glands and many reasons can be advanced in their favor. It is also significant that practically all makes of European turbines still adhere to steam-packed glands.

Several difficulties arose from the use of steam-packed glands. In the first place the escape of steam into the engine room from these glands constituted in many cases an unmitigated nuisance in cold weather. Condensation on the ceiling and roof girders caused continuous drip while at other times the turbine room itself became filled with fog. Many curious schemes are resorted to in Europe to rid the turbine rooms of this escaping steam.

Another difficulty, less serious but affecting plant operation, was the fact that this loss of steam at the glands had to be replaced by additional make-up which required added water-treating and evaporator capacity. Furthermore, refinements in the development of feedwater heating systems and of station heat balance directed attention to the heat losses in the steam escaping from steam-packed glands.

These considerations have led many power-plant engineers to specify water glands for steam turbines. Where vacuum or only small pressures exist inside the casing, the water gland alone will suffice. High-pressure glands require some labyrinth packing first with a water seal on the outside to prevent leakage.

Some have objected that the water gland consumes more power than that equivalent to the steam saved and this is possibly true. On the other hand, it saves distilled water and clears the atmosphere of vapor.

The Technical Press and Practical Engineering Education

HOW many of us realize the value and importance of the technical press in all phases of practical engineering education? In addition to the information, instruction and inspiration which it brings to the readers, it also paints for them a picture of present-day engineering activity and accomplishment; points the way to future progress, and records, at the same time, the history of the art. In the doing of these things, the technical press plays a big part in all our engineering activity but especially in engineering education.

The technical press serves, as no other agency does, the entire field—students, instructors, consulting and practicing engineers, the engineers in the plants, and the men who are endeavoring to improve themselves and to prepare for advancement.

To students the technical press brings a picture of actual engineering and industrial practice. It teaches them the practical language of industry, gives them an acquaintance with leading products and manufacturers, provides a contact with the leaders in the field of engineering, and establishes a connecting link between theory and actual practice.

Engineering instructors also profit from the technical press. It keeps them well informed and in contact with new and modern developments and gives them a true picture of the daily happenings in the field. And, in addition, it puts into their hands a supply of live text material which is used for the information, guidance and inspiration of their students.

To the engineers in the plants and to the consulting and practicing engineers, the technical press provides a means of keeping in touch with new developments and equipment in the field, indicates the future trend of events, acts as a clearing house for ideas, and sets up a forum for the discussion of timely subjects.

And to the men, whatever their status, who are endeavoring to improve their knowledge and training and to prepare themselves for promotion and advancement, the technical press is especially valuable. Containing, as it does, new and live discussions, covering the fundamental as well as the practical, it brings a regular and fresh supply of material for reading, study and reflection.

The actual benefit which any particular individual derives from the technical press depends, of course, upon just how he uses it. It may be looked through in a haphazard way or read and studied in a systematic manner so as to produce the maximum return. The reader who gets the maximum return from his technical journal uses it efficiently and gets out of it all there is in it of value to him. By so doing, he shares in the benefit of the technical press as an important factor in the field of engineering education.

THE PROPOSED ADDITION to the A.S.M.E. boiler code specifying the manner in which a hydrostatic test shall be made for the purpose of determining maximum allowable working pressure in boiler parts has received a practical try-out in the tests conducted on the headers of the new Edgar 1,400-lb. boilers. That this appendix to the code was needed is evidenced by its immediate use, and the thoroughness with which it has been prepared is indicated by the consistent results obtained from the tests reported in this issue.

In calculating the working pressure the appendix sanctions a heretofore unused proportional relation between the hydrostatic pressure at the proportional limit and the stress at the proportional limit of the material as determined under tensile test.

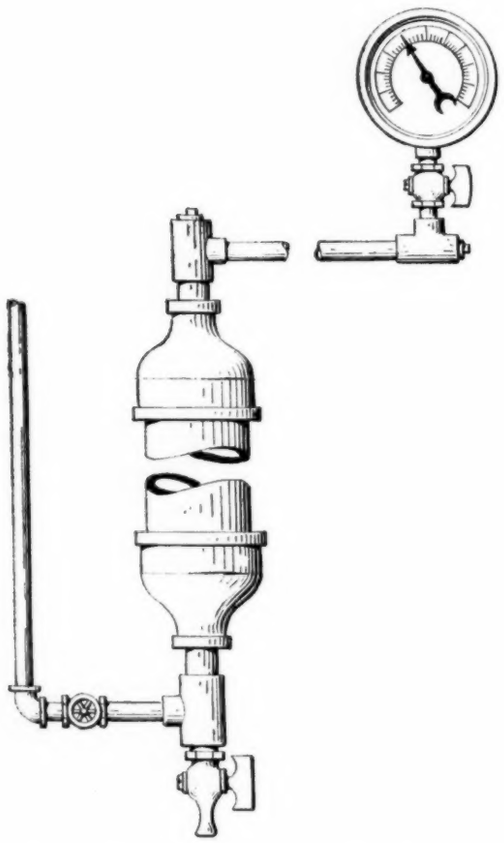
As a new tool in the hands of the designer its usefulness will be of great practical value, particularly in view of the present trend to high pressures and the consequent necessity of greater accuracy in the knowledge of the stresses existing in complex boiler pressure parts.

IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Non-Freezing Steam Gage Connections

THE engineer of a small steam plant found it necessary to locate a pressure gage some distance from his engine room so that he could "keep tab" on the steam pressure without making too many trips to the engine or boiler room. In winter time the steam line to the gage would freeze, so he rigged up the non-freezing connections shown in the illustration.



Section of gage line exposed to low temperatures was filled with oil

A 24-in. length of 2-in. pipe was fastened to the wall inside of the engine room, in a place where it would not freeze. The upper end of the pipe was fitted with a reducer, a short nipple and a $\frac{3}{4}$-in. tee, with a $\frac{3}{8}$-in. outlet, from which the steam line was led to the gage outside the building.

The lower end of the 2-in. pipe was also fitted with a reducer and a tee the same as the upper end, and the steam supply pipe from the boiler was connected through a valve to the side outlet of the tee, the lower end of the tee being closed by a drip cock. Then the 2-in. pipe and the entire line to the outside gage were filled with an oil that would not congeal at low temperatures, care being taken to exclude all air and water from the line.

With this connection no steam or condensation passes into the line beyond the 2-in. section and no more trouble was had from freezing up and bursting of the pipe.

Indianapolis, Ind. J. F. HOBART.

Lubrication Problems of the Engineer

Correct lubrication is one of the important factors in the operation of power-plant equipment. Some of the old machines still in operation are a good example of the manufacturer's or designer's lack of foresight or knowledge on the subject.

A number of years ago I had under my care two large vertical-twin-cylinder ammonia compressors of old design. The crankcases of these machines were inclosed, but the cylinders, wristpins and guides were oiled by a small rotary pump situated on the outside of the crankcase above the oil line. The pumps were driven by a small leather belt running on the crankshaft of the compressor. These machines were a constant source of trouble and annoyance due to the fact that the oil pumps were situated above the level of oil in the crankcase; they would often lose their suction, and the bearings would run dry and burn out. Another source of trouble was the small flat leather belts used to drive the oil pumps. These belts would eventually become saturated with oil and either slip or fly off the pulleys, leaving the machine without oil. A small leak around the packing gland on the shaft of the pump would cause them to lose their suction.

This trouble was finally overcome by lowering the pumps to a position where the oil would flow to them by gravity. The means of driving was changed from a leather belt to a silent chain. The moral here is, "Anything as important as an oil pump should be positively driven by a train of gears or a chain, and oil pumps or the suctions of the pumps should be submerged."

Designers of stationary equipment could get many valuable pointers by studying the methods used by automobile engineers. On the other hand, many automobile manufacturers have benefited from and used the ideas developed by stationary engineers and designers. A number of years ago I borrowed an idea from my automobile. I had charge of a plant that contained a number of ball-bearing motors. Oil is not satisfactory in a ball-bearing, as it is thrown out or escapes too quickly. Dismantling the bearings and packing them in vaseline

or light grease is quite a job. So I decided to equip all the motor bearings with standard grease-gun connections and apply the grease with a gun or compressor. The idea worked out well and saved a lot of time and labor in caring for the motor bearings

Not infrequently, the quality of the oil or grease that is being used is blamed for the trouble that is really due to faulty design of the bearing. We frequently find plain sleeve or split babbitted bearings without grooves for the proper distribution of oil or grease over the bearing surface. Many such bearings which run hot in service, when taken apart and examined reveal the fact that oil or grease has reached only a portion of the surface, or the bearing may have run hot at some time and grease or oil has carbonized and filled up the oil channels. Thereafter the bearing will not operate properly until taken apart and cleaned.

Bearings that are poorly fitted or badly worn are difficult to grease with grease cup or compressor because the grease under pressure will promptly squirt out of the bearing where it is worn, leaving the tight spots dry. However, the grease pressure system works perfectly when the bearings are in good condition and properly designed.

I had an interesting experience a few years ago with the lubrication of an oil engine. I happened to come in contact with the superintendent of water supply in a small suburban city. At the time of introduction he learned that I was an engineer and later on he told me some of his troubles. He asked me if I knew where he could find a good gas engine man, as he was having a lot of trouble in one of his pumping plants. The superintendent said: "I'll bet I've hired and fired a dozen engineers in the last six months. They keep burning out the bearings of the engine. The machine is shut down half of the time. If a man burns out a bearing on an engine I fire him; that's all there is to it." The superintendent admitted that he was not an engineer; he was an executive or office man. I suggested that the engineers might not be altogether to blame; that there was such a thing as extenuating circumstances. I knew of a fellow who needed a job and this job paid fair wages, so I told the superintendent that I would bring the man around the next day, take him out to the plant and look things over.

The next day we drove out to the pumping plant and found a 50-hp. horizontal gas engine belt connected to a deep-well pump. All an engineer had to do was to keep the engine running and the machinery oiled. I had been thinking the problem over during the night and had come to the conclusion that I knew what the trouble was before I ever saw the engine. I had had a similar experience years before and it had come back to me. All the engine bearings were oiled by means of sight-feed glass-body lubricators, the oil feed being regulated by a needle valve in the lubricator. These needle valves are easily stopped up by a small amount of foreign matter in the oil. Two fifty-gallon containers of lubricating oil were in the pumphouse. This oil and that in the oil cups was found to contain minute particles of what appeared to be cotton waste or fine particles of cotton. This substance was difficult to see in a lubricator. The quantity of it in the oil was small, but sufficient to stop up a lubricator sooner or later. How the cotton waste happened to be in the oil was a mystery. It might have been deliberately placed there by someone with a grudge against the management. The lubricators were thoroughly cleaned and the oil strained through cheese cloth to remove the cotton waste. Thereafter no further trouble was experienced with burned-out bearings.

Monrovia, Calif. ROLAND L. TULLIS.

An Interesting Trouble Call

The complaint bureau of a large Eastern electric company recently reported an interesting case of voltage unbalance. Investigation of the situation showed that a plant was receiving three-phase power from one bank of transformers and light from a separate lighting transformer. In accordance with standard practice the mid-

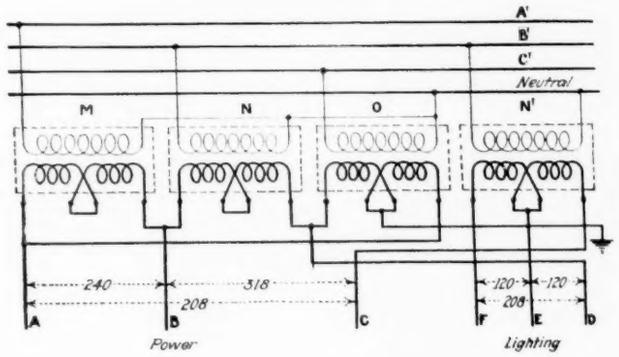


Fig. 1—Voltages on circuits with one power and one light lead interchanged

point of the secondary of the lighting transformer was grounded, as well as one of the power transformers.

Investigation showed the transformer installation to be satisfactory. The three power wires along with the three lighting wires all left the transformer room by way of one conduit. At the other end it was found that one power wire had been interchanged with one lighting wire, shown by *C* and *D* in Fig. 1.

A balanced system in the power circuit no longer resulted, and the voltages were those given in Fig. 1. The two 120-volt lighting circuits were normal, but the voltage

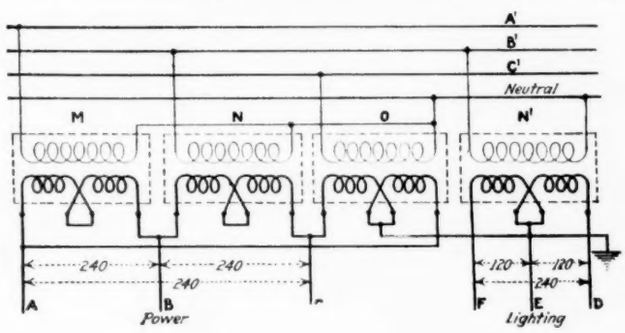


Fig. 2—Normal voltages on system with correct connections

FD between the outside wires was only 208 instead of 240, as would be expected, because of the changed phase angle between voltages *FE* and *ED*. Two phases of the power circuit also supplied incorrect voltages. Persistent blowing of the fuses in one phase of this circuit first drew the user's attention to the mistake. The voltage *BC* was found to be 318, as in Fig. 1, which was sufficiently above normal to cause such trouble. Fig. 2 shows the corrected circuit with the normal voltages.

Flushing, N. Y. VERNON W. PALEN.

COMMENTS *from* READERS

Steam Quality from Boilers

THE EDITORIAL on Steam Quality from Boilers in the June 21 issue draws attention to problems of considerable importance to engineers, and not the least of these is that of moisture in steam, and the necessity of correct sampling and calorimetry. There is room for a great deal of research on these two questions alone, especially with the increasing importance of the steam quality at higher pressures.

The Power Test Code of the A.S.M.E. seems to be the only authority which gives the problem much attention; unfortunately, I have no copy of the code available and have to rely for my information on a pamphlet

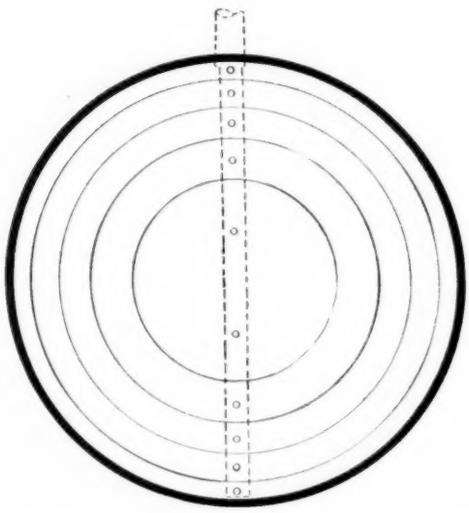


Diagram of steam pipe divided into five equal areas to give uniform sample

issued by the manufacturers of a steam dryer. Dealing first with the sample pipe, it is stated that this should be made of ½-in. iron pipe, closed at the end, and that it should extend to within ½ in. of the wall of the steam pipe. Not less than twenty holes, ⅛ in. in diameter, should be drilled round the periphery in irregular or spiral rows. It will be obvious that such a sample pipe will only give a true average sample if the moisture content of the steam is uniform throughout the steam pipe. The reason for this will be clearer from the figure, which represents a pipe divided into five equal areas, so that the quality of the steam in each area is taken to the calorimeter as it exists in the pipe. This assumes that the steam velocity is fairly uniform over a cross-section of the pipe. The holes in the sample pipe, shown dotted in the figure, should therefore be drilled to take equal quantities of steam from each area, and the ordinary sample pipe does not do this. Some engineers may say that this is taking theory too far, but the fact remains that the Code bases its test for the normal of a throttling calorimeter on the supposition that steam at the top of the pipe will be dry, which would imply that the committee did not consider that the quality is uniform at all parts of the pipe. Rules to be observed in locating the sample pipe need not be discussed here.

The normal temperature of a throttling calorimeter is the temperature of the lower thermometer when sampling perfectly dry steam. The Power Test Code recommends that a plain sample pipe, without perforations and with an open end projecting upwards, be used for calibrating the throttling calorimeter. With the boiler working steadily it is assumed that steam at the top of the steam pipe will be dry saturated. It seems to me that if the boiler is working at a high rating the steam will almost certainly not be dry, and at low ratings it is not likely to be dry because of the radiation from the pipe, which cannot be entirely eliminated, and there must therefore be some moisture present. Under average conditions a one-half per cent loss of total heat of the steam will cause a one-half per cent moisture content. It is practically impossible to get dry steam by this method, and there seems to be no objection to using slightly superheated steam for calibrating, a suggestion made to me by an operator in a paper mill in California. Steam superheated about 10 deg. F. will give practically the same radiation, kinetic energy, and other losses, as saturated steam at the same pressure. It is a simple matter to calculate the theoretical lower thermometer temperature and the difference between the theoretical and the actual temperature should not be more than one degree F. Lagging of the calorimeter is important, and any new design must be calibrated. There are further points, but the two suggestions may be of interest; they are here made with the object of promoting discussion and exchange of experiences.

Northwich, England. B. M. THORNTON.

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Is Positive Pressure in the Combustion Chamber Desirable?

IMPORTANT changes are being made every year in the design of boiler room equipment, and the modern stokers, boilers and furnaces reflect these changes to a marked degree. During this progress of development, the hand-fired natural-draft furnace has ben replaced to a large extent with mechanical stokers of the natural-draft type. These were either of the underfeed, overfeed, or chain-grate design and the air for combustion was drawn into the furnace by draft created through the action of a stack or its equivalent. This method of firing required tight settings to prevent the air from being drawn in at places where it did not aid in the complete combustion of the fuel. The development of the natural-draft mechanical stoker went a long way toward increasing furnace efficiency by reducing the large quantities of excess air which entered through the furnace doors when firing the coal or when the fires were barred to increase the rate of combustion. However, these stokers did not reduce the infiltration of air through the furnace settings

and only increased the rate of which the fuel could be burned in so far as they kept the fires clean and free from clinkers.

The development of the forced-draft stoker has further improved furnace efficiencies by reducing the infiltration of air through the settings and by increasing to a marked degree the rate of which coal could be burned per square foot of grate area. By forcing the air through the fuel bed it was possible to reduce the furnace draft to a balanced condition or equal to that of the surrounding atmosphere. This naturally reduced the infiltration of air and at the same time increased the rate of combustion, since the air required was obtained independent of draft created by the stack. The rate at which fuel could be burned was now limited principally to the ability of the stokers to keep the fires in a good condition and free from objectionable ash and clinker. But again the advantages of decreased air infiltration was partly lost as it was found impracticable to carry a balanced draft in the furnace at the high rates of combustion, as the furnace temperatures became too high and rapidly destroyed the brickwork.

The development of the metal or water-cooled wall is now solving the question of excessive maintenance of brick settings and with this construction the furnace temperatures are under better control of the designers and operators. With these furnaces it is not necessary to adjust draft conditions to preserve the furnace linings. Boilers and steam generators are being built, fired with pulverized coal, oil or gas, which are completely surrounded with water-cooled walls. Back of these walls is a thin layer of insulating material held in place by a metal covering. These units are built to operate under balanced draft conditions in the furnace, but when economizers and air preheaters are used the draft at points in the economizer or air heater may be 2 or 3 in. due to the suction of the induced-draft fan overcoming the resistance to gas flow through the unit.

With this modern design of furnace, economizer and air preheater, it would be possible to operate with the furnace under pressure throughout the entire path of gas travel. The metal box construction can be made air tight by welding or packing all joints, which is done at the present time to a large extent. There would be no new problems due to expansion joints, and with our modern means of ash sluicing and present methods of firing pulverized coal no new problems would be encountered. The question of removing defective boiler tubes would be no more difficult than with the present designed units.

Knowing that it is possible to operate with a positive pressure in the combustion chamber and throughout the path of gas travel we would next want to know whether there are any advantages in doing so. With such a system no induced-draft fan would be required. The forced-draft fan would be designed to deliver air at sufficient static pressure to take care of the pressure drop across the entire unit. The power required to supply the air at this pressure would be somewhat less than that of the forced-draft and induced-draft fans of present-day units, assuming that there were no stack. This is necessarily so, as the increased volumes due to temperatures of the exit gas is not handled by the fan. The initial cost of fans and driving motors would be less, as the fans can be of the high speed type which has not been possible in present-day induced-draft fan design.

By forcing the air through the entire path of gas travel the control of the quantity of air would be much simplified as it would be regulated entirely by the speed of one fan. There would be no need of cumbersome dampers in the breechings, or regulators to hold the furnace draft at a definite amount by correlating the speed of the induced-draft fan to that of the forced-draft fan or by controlling the dampers.

With the products of combustion under pressure the question could be asked, "Would the rate at which combustion takes place be increased due to the greater concentration of coal and air?" Such would undoubtedly be the case if the turbulence of air and coal were increased by proper burner design. Furnaces designed to meet this method of firing might lend themselves to smaller and simpler construction and in this way reduce the initial cost of the installation.

We have passed through the period of development where the air for combustion is drawn into the furnace by natural draft and are now passing through the period of the forced-draft and induced-draft design with balanced conditions and it is possible that the next period will leave both these systems behind and introduce furnaces built to operate under pressure. We often pass from one extreme to another during the progress of development of equipment, so it would not be unusual if this took place. It is my opinion that this subject will warrant investigation in the further study of combustion problems.

Chicago, Ill. L. W. HAYWARD.

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Why Boilers Vibrate

IN ANSWER to the communication of E. D. Hewlett which appeared in the July 5 issue, I will relate a similar experience we had. In our case the new plant consisted of a 24x42-in. Corliss engine and four horizontal tubular boilers. Vibration in the boilers and piping was so severe that in less than three years the furnaces had to be rebuilt; the walls had become mere piles of loose brick. The trouble was due to the vibratory action caused by the stopping and starting of a 40-ft. column of steam in the 8-in. main 186 times per minute. The effect of this sudden stoppage of flow was no doubt equal to a blow of several hundred pounds and set up a vibration that no amount of bracing, tying or clamping would overcome. In the piping were 90-deg. bends from the boilers and a like bend at the engine.

The trouble was overcome by placing near the engine a receiver having a volume equal to $2\frac{1}{2}$ times that of the engine cylinder. The 90-deg. bend was attached to the inlet side of the receiver and a U-bend placed between the receiver and engine. This cured the trouble so far as the boilers and piping were concerned, except that a strut had to be placed across the legs of the *U*-bend to dampen a slight vibration at this point. As this happened twenty years ago and there has been no trouble since, we feel that it was a cure.

The receiver was made of boiler steel with the longitudinal seam double-riveted; one head was convex, the other concave. It was designed by me and I figured the strength from the usual formula, then added quite a percentage to make sure it would stand up under service. The man who has to stay on the job and see a thing through, has an interest in it that no contractor or designer ever can have and will usually make a thing a little stronger than needed.

Anderson, Ind. J. O. BENEFIEL.

New and Improved EQUIPMENT

"Megger" Tester Reads Ground Resistance Directly

An instrument for measuring and indicating directly on a scale the resistance to earth of ground connections has been put on the market by James G. Biddle, 1211-13 Arch St., Philadelphia.

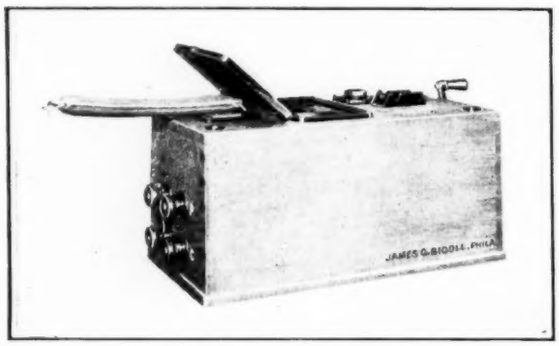

Fig. 1—Ground-resistance tester with case opened ready for operation

Fig. 1 is a view of the instrument and Fig. 2 shows the connection diagram. To conduct a test connections are made to the ground connection and to two temporary reference grounds which may be rods or pipes driven 2 or 3 ft. into the earth, 12 to 15 ft. away from the ground being tested, Fig. 2; or both may be connected to a water pipe if convenient.

The principle of operation is that of the alternating-current fall-of-potential method. A Bureau of Standards report on ground resistance measurements states that "in case of driven pipes about 90 per cent of the total resistance is generally encountered in the first 6 to 10 ft. of earth. Current supplied by a hand-driven direct-current generator and changed to alternating current by a current reverser, Fig. 2, flows through the earth from the ground connection to a temporary ground connected to C_2. The potential drop from the ground connection to a temporary ground connected to P_2 is rectified by the potential commutator and actuates potential coil A of the ohmmeter. The reverser and commutator are mounted on the armature shaft of the generator, and are always in synchronism. Thus the test is made by alternating current of an odd frequency of 40 or 50 cycles, and is not affected by ground currents, either direct or alternating.

Coils A and B of the indicating ohmmeter are mounted as a unit without controlling springs and are free to move in the field of a permanent magnet. Current coil B is in series with the current circuit through the ground and with no current in potential coil A, it causes the pointer to indicate zero on the scale. This is the condition obtained when the terminals are short-circuited. When a resistance is introduced the current in B is less and the drop in potential across the resistance causes a current to flow through A. The position of the coils changes accordingly and the pointer indicates the value of the resistance.

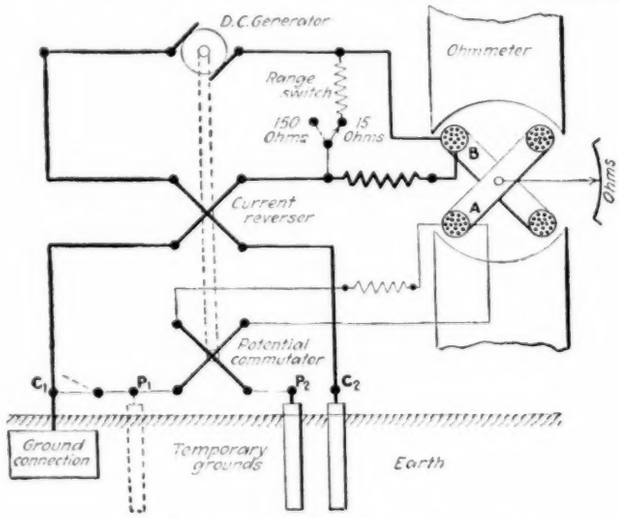

Fig. 2—Circuit through instrument and ground connections

The instrument may be used to measure the resistance of the earth between two points by removing a link between C_1 and P_1 and connecting P_1 to another temporary ground as shown by the dotted lines, Fig. 2.

Elastic-Stop Safety Nut

To obviate the need for spring washers, cotter pins or other accessories for locking a nut in position the Gas Accumulator Co., Elizabeth, N. J., has introduced the safety nut illustrated herewith.

The safety nut is simply a standard hexagon nut with an elastic cushion or ring A of hard vulcanized fiber secured in a recess at the top of the nut. The hole through the fiber ring is made somewhat smaller than the outside diameter of the bolt and is not threaded.

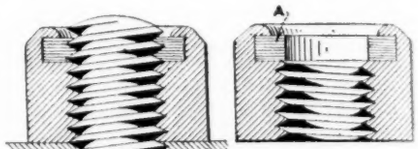

Fig. 1 and 2—Details of safety nut

When the nut is being put on, the bolt cuts a thread in the fiber ring and owing to the elastic quality of the fiber the ring tends to grip the bolt and prevent the nut from turning once it is drawn up. It is claimed that the nut can be screwed on and off hundreds of times without impairing its locking effectiveness.

New Method of Packing Condensers

A new method of packing surface condensers that has been developed recently by the Crane Packing Co., of 1800 Cuyler Ave., Chicago, eliminates entirely the use of the customary brass ferrule and permits of the belling of the inflow end. The latter feature is now generally conceded to be good practice in preventing erosive action so frequently occurring at this point, and resulting in rapid deterioration of the tube. The method is pictured in the accompanying illustrations.

When applied to an existing condenser where packing was previously employed at both ends, a special metal insert fiber bushing is driven into the tube sheet tappings on the inlet end, as shown in Fig. 1. This bushing is made for a snug driving fit into the threads. It is placed on a tapered pin inserted into the tube and is then driven into the tube sheet, after which a cylindrical motor-driven expander is used to slightly

enlarge, by expanding, the tube end lying within the fiber bushing.

After the tube ends are expanded a special drift pin or bell tool is used to flare the tube ends. This tool is inserted into the tube end and is struck a few sharp blows with a hammer, with the result that the tube end develops a uniform flare or funnel effect which enlarges the entrance to the extent that it completely closes into the annular space in the threaded stuffing box, thus affording a retaining means and a protection for the end of the special fiber bushing. The metal slugs in this fiber bushing connect with the tube and with the tube sheet, so that they provide a metallic contact between the two.

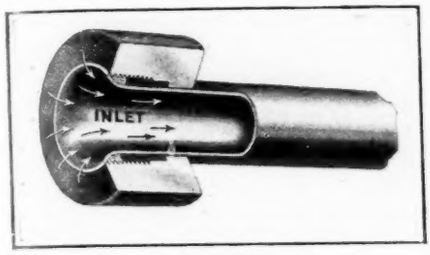

Fig. 1—Method of packing and belling inlet end

On the outflow ends of the tubes, metallic rings are inserted, but inasmuch as ferrules are not required, owing to the fixation of the tube on the inflow end, these tube sheet drillings may be filled entirely full of packing, consisting of alternate fiber and metallic rings. These rings are so proportioned as to entirely fill the tube sheet drilling to within two threads of being flush with the outer face. See Fig. 2.

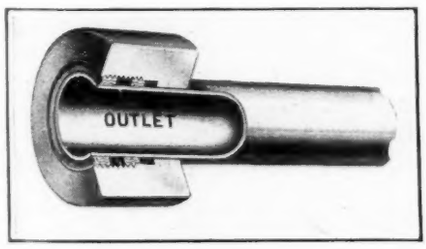

Fig. 2—Outlet end packed with alternate fiber and metallic rings

This method does not require tubes longer than the present tube dimensions of the condenser in order to obtain the funneling effect. Tubes of standard hardness specifications are suitable for rolling, as with the type of roll and the method of propelling the roll, it is not necessary to anneal the tube ends before expanding. Either 18 or 16 gage tubes may be used.

Babcock & Wilcox Return-Bend Wrought-Steel Economizer

ADAPTABILITY to steaming or non-steaming service, flexibility of design and employment of straight tubes with return bends outside the path of the gases are some of the outstanding features of the wrought-steel return-bend economizer recently brought out by the Babcock & Wilcox Co., New York.

The economizer consists essentially of a series of rows of horizontal tubes supported one about the other in a staggered position, with each tube in each row connected at either end of the tubes of the next row above or below by a flanged return bend. No intermediate headers are employed, there being used only a distributing header at the lower or inlet end and a collecting header at the upper or outlet end as shown in Fig. 1.

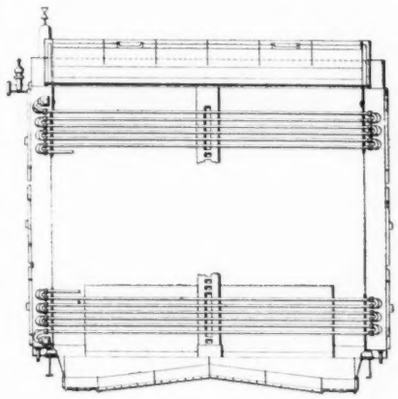

Fig. 1—General arrangement of economizer with casings and tube supports

The tubes are 2-in. seamless steel of the required gage, upset and threaded at the ends and faced for the gasket joint. The headers are forged-steel square boxes. The tubes are connected to the headers by flanged return bends as shown in Fig. 4. The return bends used to connect the ends of the tubes are of heavy seamless-steel tubing with the ends of the tubing faced to form a gasket seat below the face of the flange as shown in Fig. 2. The bends are made in two heights from the flanges and in assembling the economizer these are arranged alternately to give access to the studs connecting bend and tube flanges.

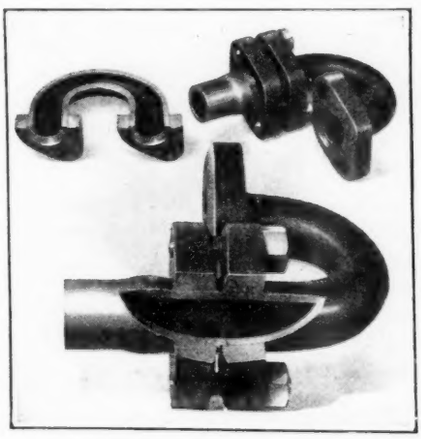

Fig. 2—Detail of return bend and tube connection

The method of supporting the tubes at the end where they pass through the cast-iron plate supports is shown in Fig. 3. The bosses on the outside of the plate facing the flanged connections are counterbored to form stuffing boxes, having a shoulder at the inner end or inside edge of the plate. When the tube is in position a split steel ring is first pushed into the box to center the tube in the hole and to close the inner end of the stuffing box. The tubes are supported in the center by flat steel bars, with recesses milled out to receive the tubes. With the supporting plates in position the tubes are clamped tightly in place to avoid vibration.

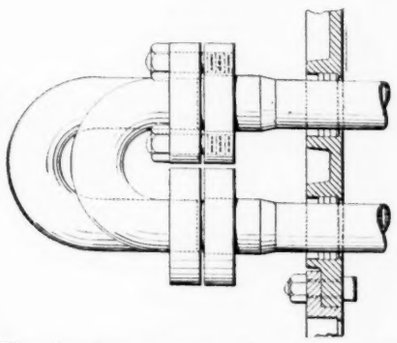

Fig. 3—Arrangement of return bends and tube end supports

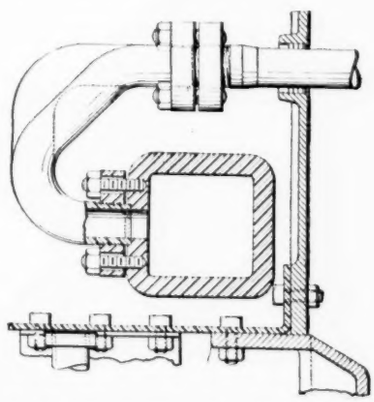

Fig. 4—Connection of inlet header and bottom tubes

As will be apparent from the illustrations liberal allowance is provided for expansion and contraction and gas- and water-tight joints are provided. The latter feature is particularly important where the economizer is cleaned externally by water. It will also be noticed that all joints are outside the path of the flue gases so that all chance of corrosion at the joints, from sulphuric acid due to the presence of moisture and sulphur in the soot accumulation or from the presence of sulphur dioxide in the flue gases, is eliminated.

The economizer is fitted with a soot hopper of hollow box-type construction and in the large unit the hopper is pitched from the center toward the ends and from the sides toward the center to allow for drainage.

Investigations of Riveted Boiler Seams That Failed by Cracking*

WHENEVER a riveted seam leaks, a thorough examination should be made, according to Par. CA-5 of the Boiler Code, bearing in mind that five possible factors may have caused the failure: 1. Material; 2. workmanship; 3. temperature; 4. time; 5. feed water.

Progress in solving this problem depends in great part upon the activity and observations of boiler inspectors, who will not only supply missing statistical data, but will bring about the cooperation of all those interested in the prevention of this type of failure.

Conclusions Reached by Parr and Straub

In June, 1926, there appeared a bulletin by Professor Parr and Mr. Straub, entitled, "The Cause and Prevention of Embrittlement of Boiler Plate."[1] The conclusion states the following:

"Embrittlement in boiler plates is caused by the combined action of stress and chemical attack. The stresses are inherent in the construction and in the operation of the boiler, while the chemical attack is caused by sodium hydroxide in the boiler water."

It will be shown later, however, that only in poorly made and leaky rivet

Fig 1—An example of poor riveting. Note welding in attempt to stop leak

seams can stresses and caustic soda concentrations occur of a magnitude which Professor Parr found requisite to do any damage.

Since then in April, 1927, Professor Parr and Mr. Straub presented a paper to the American Chemical Society entitled, "Embrittlement of Boiler Plate." In this paper the authors state that the use of the term "embrittlement" for the type of boiler failure in question, is unfortunate, because brittleness as generally understood may result from a number of causes. They recommend that "embrittlement" should be defined to mean only intergranular cracks in riveted seams and state that such cracks result specifically from highly concentrated caustic soda solution acting on boiler steel strained beyond the yield point.

Baumann's Research Work—Intergranular Cracks in Absence of Caustic

It is unjustifiable, however, to conclude from the foregoing that the mere presence of intergranular cracks proves the specific action of caustic soda if due consideration is given to the recent research of Professor Baumann, on which he reported in a paper entitled, "Occurrence of Intergranular Cracks in the Absence of Feed Water." This research was carried out in order to determine whether caustic soda is a necessary element in the production of intergranular cracks. He found it possible under certain conditions to produce intergranular cracks in a boiler sheet exposed to dry air and published a photograph of a crack thus produced. He furthermore exhibits a number of other cases of intergranular cracks from steel specimens collected from time to time where it was certain concentrated caustic soda was absent.

Professor Parr's conclusion was that the high stresses (above the yield point) necessary before embrittlement can occur are inherent in the usual construction and operation of a boiler. As to this it must be pointed out that whenever the results of a thorough investigation of a failure of this type has been published, it has always been found that the fractured part was defective either in material or workmanship or both. Therefore, more than the ordinary stresses inherent in well made riveted boilers appear to be necessary before such failure occurs.

Reports of Union of Large Steam Boiler Users (1923-1926)

It is for this reason that boiler users have united to investigate the causes of boiler failures and to conduct research work to prevent their occurrence in the future. The most active association in this respect is the Union of Large Steam Boiler Users in Germany. Whenever a boiler belonging to a member of this Union fails, the defective parts are submitted to impartial research institutes where they are thoroughly examined. Most of this research work has been carried out by the Material Testing Station at Stuttgart directed by Professor Baumann, and the Government Material Testing Station at Dahlem, directed by Professor Bauer.

The Union of Large Steam Boiler Users published the result of these investigations from time to time. From 1923 to 1925 out of twenty-five reported failures of horizontal water-tube boilers which cracked, nineteen boilers (76 per cent) failed at the riveted seam connecting the cross-box with the drum.

In 1926, Doctor Guilleaume, the chief engineer of one of the largest plants belonging to the Union of Large Steam Boiler Users, reported the results of thirteen further investigations.

Eight of the thirteen reports deal with horizontal water-tube boilers, and it is quite significant that in all these cases

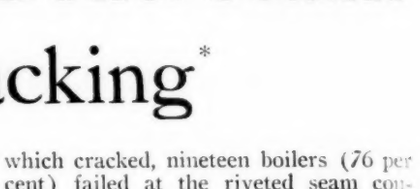

Fig. 2—Edge of plate split by improper calking

the failure occurred at the same location mentioned above, namely, in the seam connecting the cross-box to the drum.

The reports furthermore show that in all the cases several of the following defects existed:

1. Inferior material. The tensile strength, elongation and impact values were frequently found to be lower than permissible.
2. Inferior workmanship.
   (a) Improper manufacture of the calking edge: that is, the edges of the plates, etc., were not planed or milled to remove the portions crushed in shearing.
   (b) Improper heat treatment as evidenced by coarse-grained brittle microstructure.
   (c) Poorly made and fitted rivet holes in which there was evidence of the use of drift pins.
   (d) Unsatisfactory fitting. In one case hammering was resorted to.
   (e) Poor riveting work. Fig. 1 illustrates a case of this kind and also shows that welding was resorted to in an unsuccessful attempt to stop the leaks at the calking edge. It was furthermore found that this welding had damaged the material by coarsening the grain structure.
   (f) Riveting pressure too high.
   (g) Improper calking of rivet heads and edges of plates. Fig. 2 illustrates the splitting of the plate edge by improper calking.

Deposits found in one case in the cracked as well as in the sound seams indicated that the seams had leaked. However, here, also, deposits found in the cracked seam showed no alkaline

*Excerpts from paper by S. B. Applebaum, Assistant Technical Manager, The Permutit Co., read before the Nashville meeting of the National Board of Boiler and Pressure Vessel Inspectors.

[1]University of Illinois Bulletin No. 155.

contents, whereas deposits in the sound seams were alkaline. The report concludes, therefore, that in these cases also caustic soda did not influence the formation of the cracks.

The remaining two reports deal with the failure of drum heads. One case concerned a boiler explosion where the head failed at the knuckle. The radius of curvature was far too small and corrosion had accelerated the failure. The other case relates to rivet-hole cracks in a head improperly shaped. In addition the material was found to be of poor quality and improper heat treatment had been used.

A further case of this type of failure was reported recently from the Middle West. Fig. 3 shows a cross-section of the seam, connecting the cross-box with the drum. The illustration clearly shows the poor fitting of the parts.

Recent Improvement in Fabricating Methods

Boiler manufacturers are realizing the importance of properly fitted and tight riveted seams. To insure greater accuracy of curvature of the plates in the seam, one large boiler manufacturer is

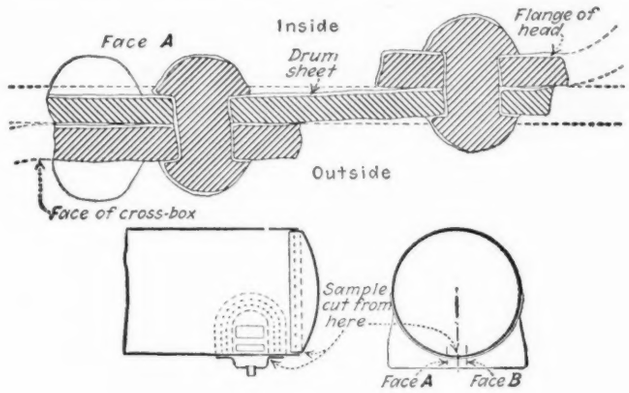

Fig. 3—A poor fitting seam

now die-forming instead of rolling. In addition, before assembling, all the surfaces of a joint are thoroughly cleaned and polished with carborundum blocks, so that a metal-to-metal contact over the entire surface in the seam is obtained. Furthermore, the importance of grinding the rivets is pointed out and the seams are calked on the inside by newly developed calking machines in the attempt to prevent the penetration of boiler salines in between the contact surfaces of the seam.

Boilers made by such improved methods will be free from the defects always found by thorough examination of actual failures. This is obviously the path of progress in remedying the first of the causes which Professor Parr has pointed out. Such properly made boilers will, likewise, remove the possibility of the second cause, namely, of high concentration of caustic soda in the seams.

Professor Parr, in Bulletin 155, stated that a concentration of caustic soda of 20,000 grains per gallon (35 per cent solution) was considered necessary as one of the two factors that cause embrittlement. Since the usual concentration of boiler salines within the boiler proper is under 500 grains per gallon, the ratio of concentration within the seam to the liquid in the boiler would have to be about 40 to 1. Professor Baumann's test showed that with a tight but not properly made seam he was not able to get a ratio higher than 3 to 1 and with a leaky pocket the ratio, also, did not exceed 3 to 1 under the test conditions. It is evident, therefore, that a seam properly made, so that it is tight, will afford no possibility of reaching the concentrations considered dangerous, as long as the boilers are properly blown off so that the salines contain less than 300 to 500 grains per gallon of total dissolved solids. With improperly made seams, however, that leak, the location and the relative size of the openings into the seam and from the seam to the outside may affect the concentration reached.

Special Boiler Steel, Less Sensitive to Deterioration

Doctor Fry, of the Krupp Works, Germany, recently read a paper on "The Behavior of Materials Used in Boiler Construction when Subjected to Service Conditions."[2] He states that the standard boiler steel of today is frequently damaged by "aging." By "aged" steel is meant specifically a steel that has been subjected to cold deformation and subsequent short exposure to a temperature of about 200 deg. or more C., or longer exposure to lower temperature. Steel is also brought into the aged condition if the deformation itself takes place at about 100 to 300 deg. C., that is, in the blue-heat range which may occur during riveting.

The effect of "aging" upon standard steel is to decrease its impact value and also to render it more sensitive to attack by external corrosive agencies. The impact value is determined by the "notched bar impact test." The ordinary methods of testing steel generally in use today such as to determine the tensile strength, elongation, chemical composition, are frequently not sufficient to disclose this change in property due to aging. But with the impact test Fry discloses that a specimen of standard boiler steel which under normal conditions showed an impact value of 25 mkg per sq. cm. had become so brittle by aging, that its impact value dropped to 2.8 mkg per sq. cm., a decrease of nearly 90 per cent. Such low impact

Fig. 4—Cracked boiler plate showing diagonal strain lines

values are frequently found in boiler plates that have failed during operation. It is of importance to note that the impact values of steel decrease sharply at certain varying temperatures. Standard steel in good condition has these low impact values at temperatures below the freezing point of water. However, the effect of aging such standard steel is to raise the temperature range at which such low impact values are found so that aged standard steel is brittle at room temperatures. This fact is of importance because so many boilers fail during a cold hydraulic test.

A second indicator which Fry developed to disclose the bad effect of aging

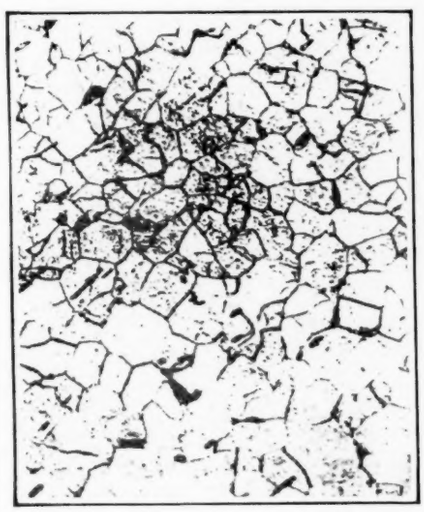

Fig. 5—Compare the grain boundaries in the strained area (central) with those outside the area

is a special etching method by which it was found that steel damaged by aging shows dark lines or bands called "strain configurations." Fig. 4 shows a typical cracked boiler plate with the strain configurations developed by this special etching method. Fig. 5 shows a large magnification of an area containing a strain configuration band. It will be noted that within this area the grain boundaries are visibly disturbed. It is evident therefore that aging has weakened these grain boundaries so that when a failure occurs in such an area it

[2] Before the Union of Large Boiler Users at Cassel.

is natural for the crack to follow these weakened grain boundaries and therefore be intergranular.

As previously stated above, standard steel in an aged condition also shows a sensitivity to corrosion. But the formation of intergranular cracks accelerated by such corrosion should still be attributed to the original weakening of these grain boundaries by the aging of the steel before corrosion started.

The effect of aging is not revealed by the mill test since this test is made before any deformations take place. Various steels do not suffer to the same extent from aging even though their original physical properties as determined by the usual mill tests and their chemical composition are identical. Fry therefore set out to make a steel which would be less sensitive to the effects of aging, and the paper, above referred to, discloses that he was successful. The special steel was named "Izet" steel. Standard steel when deformed 5 per cent or more decreases in impact value over 80 per cent. The special steel not only shows a higher impact value in the unstressed condition but when deformed even 20 per cent, the impact value does not drop off appreciably.

The Influence of Feed Water

As to the action of the feed water, it must be pointed out that the presence of caustic soda in boilers is necessary for proper boiler operation. It is impossible to avoid the formation of scale on the one hand and corrosion on the other if caustic soda is absent. Acid water must obviously be neutralized by soda ash to render it alkaline, and such soda ash will decompose in the boiler to form caustic soda. Likewise, distilled water must be treated with alkali to protect the boilers from corrosion as well as from scale that might result from condenser leakage. Recent tests[3] show that pure distilled water which may be neutral at normal temperatures becomes distinctly acid at higher temperatures and therefore must be neutralized by alkali to prevent corrosion of the boiler.

The recommendation of Professor Parr and Mr. Straub that sulphates present in the water in amounts equal to 2 to 3 times the soda ash will counteract any effect which the highly concentrated caustic soda may have on over-stressed material has been inserted as a temporary suggestion in the appendix of the A.S.M.E. Boiler Code pending further investigation. The mechanism of this protecting action has not yet been established, except that Professor Parr mentioned before the N.E.L.A. last year that he thought the effect to be a mechanical one. If the action is mechanical, then clogging the seam by any salt less soluble than caustic soda will have the same effect provided, of course,, that the solubility of the salt is low enough and the precipitated salt itself is not corrosive.

Experiments are being made in a number of boiler plants throughout the country to change the ratio of sulphates to carbonates in accordance with the foregoing suggestion. Various chemicals may be employed, such as alum, sulphuric acid, sodium sulphate, sodium sulphite and sodium bisulphite. It will take a number of years before these experiments will indicate whether a change in this ratio has had any inhibiting effect in the failure of such boilers. In the meantime the path of progress lies in perfecting the workmanship as well as the materials used in boiler construction. For low or medium pressures riveted seam construction can be improved to render satisfactory service. For very high pressures, however, it is becoming generally recognized that riveted seams must be entirely abandoned. Forged or hammer-welded construction has come into general use for high pressures and even for medium pressures abroad. Such construction avoids the accumulation of large steel masses in seams which always give rise to non-uniformity of heat conduction. Secondly it permits proper annealing of the finished drum (which is impossible with riveted seams) so that the undesirable continuously acting fabricating stresses are satisfactorily removed. After annealing, the forged or hammer welded drum can be subjected to high hydraulic pressure in order to secure a perfectly circular shape and then again annealed to remove stresses thus introduced.

[3]Berl, Staudinger and Plagge, Verein Deutscher Ingenieure, Mitteilungen uber Forschungsarbeiten, No. 295, p. 9.

Composition and Testing of Transformer Oil

OILS used in electric transformers are all of mineral origin, and they must maintain proper viscosity, flash point, density, point of solidification, etc., at operating temperatures.

Unrefined mineral oil has approximately the following composition:

Carbon	80 to 88 per cent
Hydrogen	10 to 14 per cent
Oxygen	0 to 1 per cent
Nitrogen	0 to 1 per cent
Sulphur	0 to 5 per cent

The various hydrocarbons can be classified in two groups: Saturated hydrocarbons, which are stable, and unsaturated hydrocarbons, which are unstable.

Saturated hydrocarbons are those in which all the valences of the atoms are satisfied, and their dominant characteristic from a chemical point of view is their great stability.

Unsaturated hydrocarbons, on the other hand, do not have all the valences of their atoms satisfied, hence are chemically unstable. They oxidize easily, and tend to form solids insoluble in the oil.

Mineral oils in general may be divided into three groups:

Paraffine oils, composed for the greater part of a class of saturated hydrocarbons. These oils are produced largely in Pennsylvania and Ohio. Their point of solidification is high.

Asphalt oils, rich in asphalt products, come from California and Texas, and have a low point of solidification.

Naphthene oils are Russian and form a class in themselves. They are very stable and will not solidify at any temperatures encountered in our climate.

The Refining Process

The constitution of the oils is complex, and the method of refining has much to do with their life in a transformer. Unsaturated hydrocarbons react with the oxygen of the atmosphere and form deposits, or sludge. The refining process ordinarily consists of two parts:

The oil is treated in large vats with a quantity of concentrated sulphuric acid which dissolves the unsaturated hydrocarbons and has no effect on the paraffines and naphthenes. Violent agitation insures intimate contact of all the molecules of oil with the acid. The acid is then separated from the oil by decantation and the oil is neutralized by a solution of soda.

The second operation consists of a decoloration process by means of natural silicates. The decolorant is neutral, and its action is physical.

After these treatments the oil is dehydrated by centrifugal action, and is ready for use.

Testing the Oil

Ordinary physical tests are not sufficient to identify the oil and give an accurate indication of the degree of refinement and stability at operating temperatures. It becomes necessary to devise an analytical method of reproducing in miniature, and with accelerated action, the alterations occuring in the oil when in service. Numerous research enterprises are engaged in the elaboration of methods of testing and measuring the tendency of the oil to form deposits under the simultaneous action of the air and heat.

Several processes have beeen employed, and the results obtained are usually widely different. The *Société Alsacienne de Constructions Mécaniques* has studied a standard method in laboratories suited to the purpose.

Test tubes 15 mm. in diameter and 150 to 160 mm. high are filled to about 0.8 of their height with oil, which weighs 10 or 12 grams. A group of these test tubes is suspended in containers of oil and covered. These in turn are suspended in a tank filled with oil or parafine, and containing electric heating coils with an automatic regulator which keeps the temperature at 150 deg. Uniformity of temperature in the tank is maintained by means of a mechanical agitator, driven by a small electric motor. The whole equipment is compact and makes a very satisfactory unit.

The tendency to form deposits in this test is considerably affected by the diameter of the tubes and the amount of oil in them, as the relative surface exposed to the air is important. Under constant conditions, however, consistent results have been attained.—*Abstract from the Bulletin de la Société Alsacienne de Constructions Mécaniques.*

RECENT PUBLICATIONS

ARC WELDING AND CUTTING MATERIAL. Published by the General Electric Co. Cloth, 8x10½ in.; 139 pages; illustrated; Price, $1.

This manual is intended to provide a means whereby one may acquire a familiarity with the manipulation of the electric welding arc and its characteristics and applications. The text is divided into four parts: Part I, containing a general treatise on arc welding; Part II, consisting of a training course for arc welding operators; Part III, containing illustrations and explanations of the common applications of the arc welding process; Part IV, describing the General Electric arc welding apparatus.

THE HISTORY OF THE INCANDESCENT LAMP. By John W. Howell and Henry Schroeder. Published by the Maqua Company, Schenectady, N. Y., 1927. Cloth; 5½x7½ in.; illustrated; 208 pages.

Edison's development of the incandescent lamp has been characterized as the foundation upon which the electric light and power industry of today has been built, but there were many attempts made to produce a satisfactory electric light before this. In the first chapter of this little book the author reviews these earlier developments. Chapter II discusses Edison's invention of a practical incandescent lamp, a complete lighting system and their commercial introduction. The remainder of the work follows through the refinements that have made the modern incandescent lamp possible. The authors have told an interesting story of one of the important branches of the electrical industry and added an important link in the history of that industry's development.

GRAPHIC THERMODYNAMICS. By W. S. Huntington. Published by D. C. Heath & Co., New York. Cloth; 5½x7¾ in.; 200 pages; 67 illustrations and charts. Price, $2.80.

As stated by the author, the purpose of this volume is to present a graphical method for the analysis of heat problems. Essentially, he has constructed a number of charts whereby the various values of internal energy, etc., ordinarily calculated from values taken from tables of vapor properties, can be read direct from curves. When an engineer has numerous similar problems, such charts should be of benefit, but unfortunately those shown in the volume are on so small a scale as to be of little value, save to reveal how large-scale charts can be constructed. The author, in the preliminary chapter, deals with thermodynamics in a way unusual in textbooks and clarifies some of the points usually perplexing to the tyro. In a few instances his lucidity wavers and one must know considerable of thermodynamics to avoid the pitfalls. Thus he states in regard to isothermal work that "if pressure per square inch be used, the result must be multiplied by 144 to convert it from inch-pounds to foot-pounds." On the whole, the author has developed an interesting line of thought, and the volume is entitled to a wide-spread circulation. Its value would be increased many-fold if large workable charts could be obtained with the book.

THERMODYNAMICS. By J. E. Emswiler, Professor of Mechanical Engineering, University of Michigan. Second edition (1927). Published by McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Cloth, 6x9 in.; 296 pages. Price, $3.

The second edition of this book, first published in 1921, follows in general the arrangement adopted for the first edition. The particular advantage and merit of the book come from the order and method of presentation, which, as the author states, are "somewhat unorthodox."

The generally established routine of so many of our books on Thermodynamics is not followed. The book has been designed to catch the real interest of the student from the beginning, by building an understanding of thermodynamics, as applied to engineering, upon the background of the student's experience and practical knowledge.

Consequently, the abstract phases of the subject, and a deep mathematical treatment, do not confront the student or reader at the beginning, the abstract phases, as such, being placed near the end of the book. Instead of the usual order, the student is introduced to a study of steam and its properties, followed by an unusually thorough presentation of the steam power plant as a heat engine. In these sections of the book the matter of heat charts and diagrams is so well presented that the student should have no difficulty in grasping the principles and in using these for the solution of practical problems.

Following in order are taken up the subjects of vapor refrigeration, compression and expansion of permanent gases, mixtures of gaseous substances, and the hot-air engine. At this point in the book the author takes up a discussion of the energy laws of thermodynamics, followed by chapters on the degradation of energy, the conservation of heat, the flow of fluids and kinetic engines. He concludes with a chapter on miscellaneous subjects including the kinetic theory of heat. All of these are presented in a logical and systematic manner and, what is more, the discussions are readable and interesting.

Of particular interest is the new chapter dealing with the various means employed for extending the range of efficiency of the Rankin Cycle. This explanation of modern practice is exceptionally good and will be appreciated by the practicing engineer as well as by the student who is considering the subject for the first time.

Although the order and method of presentation used have many distinct advantages, yet there may be some difficulties for the student who has little or no practical knowledge of power-plant equipment or operation. Supplemented by good teaching and practical contacts, however, the arrangement should prove workable. In addition, some of the discussion in the early portions of the book presupposes a knowledge of certain fundamental facts and principles which many students may not have. In these cases, however, the material is available at the rear of the book.

As a whole, the book is an excellent presentation of the subject, taking up as it does, the matter in an order and in a manner that will be appreciated by the teacher, the student and the engineer in practice.

HANDBOOK NO. 10 OF REVISED NATIONAL ELECTRICAL SAFETY CODE. Published by the Bureau of Standards, Washington, D. C. Price 60 cents.

The latest safety rules for the installation and maintenance of electrical supply and communication lines are contained in Handbook No. 10 of the Bureau of Standards, which has just been issued. This handbook covers the subject arranged in such a way that the information desired can be easily found. Handbook No. 10 contains Sections 20 to 29 of the revised National Electrical Safety Code, which has been issued in a series of separate handbooks, Nos. 6, 7, 8, 9 and 10, each dealing with some particular part of the code. The entire code will be issued later as a single publication. While this latest part of the code is not of so much general interest as the parts dealing with radio equipment and electrical utilization equipment, it will be found of the greatest value to electrical engineers, maintenance officers, railroad officials, and all others interested in the construction and operation of electrical transmission lines. Many tables, graphs and line drawings are included, which greatly increase the value of the text.

GROSSKRAFTWERK RUMMELSBURG. Published by the Berliner Stadtische Elektrizitats-Werke Akt.-Ges., Schiffbauerdamm 22, Berlin NW6, Germany. Modern art cover view of plant. Paper; 8½x11½ in.; many illustrations.

This is a well illustrated description of the Klingenberg high-pressure power plant at Rummelsberg, Germany. The first section of this plant contains three 100,000-kva. turbine generators that are supplied with steam at 460 lb., and 752 deg. F. As an appendix to the plant description are a number of pictures showing the plant during the progress of construction.

NEWS *of the* FIELD

Colorado River Parley Shows Hope for Settlement

A basis for discussion was established and a general feeling of hope prevailed on the first day of the Seven-State Colorado River Conference held in Denver Aug. 23. Governors of six of the Colorado River basin states are in attendance, with their river commissioners and other advising experts.

The governors in attendance were: Frank C. Emerson of Wyoming, George L. Dern of Utah, R. C. Dillon of New Mexico, C. C. Young of California, George W. P. Hunt of Arizona, and William H. Adams of Colorado, the host. Gov. F. B. Balzar of Nevada was represented by George B. Malone, Nevada State Engineer.

The conference was called by Governor Adams and the other three upper-basin states, Wyoming, New Mexico and Utah, in an effort to arrive at an amicable settlement of the Colorado River controversy and an early ratification of the river compact drawn at Santa Fe, N. M., in November, 1922.

California and Arizona

Owing to the inability of California and Arizona to agree over apportionment of the water allocated to the three lower-basin states by the treaty, Arizona has never approved the compact and California's ratification was conditional on the construction of the Boulder Canyon storage dam.

The outstanding feature of the first session was the statement by Governor Hunt that Arizona would unconditionally approve the Santa Fe pact whenever his State was able to arrive at a supplementary agreement with California regarding the lower states' shares of water. For four years the general impression has been that Arizona would not approve the seven-state treaty under any circumstances, and Governor Hunt's announcement was taken by representatives of the other states to be the most hopeful sign since the treaty was drawn.

The Arizona delegation also made a definite proposal for division of the water allocated to the lower states, as follows: To Nevada, 300,000 acre-ft. a year; the remaining 7,200,000 acre-ft. to be divided equally between California and Arizona.

Large Storage Plan Favored

Governor Hunt also offered to refrain from pressing Arizona's demands for consideration and settlement of the power question — another stumbling block to an agreement with California —until a future date, and to confine the present discussion solely to the division of water, providing the California-Nevada-Arizona subsidiary compact states definitely that the power question be settled before any project construction starts.

Speaking for California, Governor Young declared that his State was extremely desirous of securing an early ratification of the pact. Stating that California must always insist that a large amount of storage be provided against dry years, as under the Boulder Canyon plan advocated by his State, the California Governor offered a counter proposal to that of Arizona.

Under this plan the question of division of water between the low-basin states would be left for final decision to a commission composed of one member from each of the seven basin states and two engineers to be appointed by the President of the United States. In reply to a direct question from an Arizona commissioner it was said that California would not suspend its activities to secure passage of the Boulder Canyon dam bill by Congress pending the findings of such a commission.

The federally constructed dam is opposed by Arizona. The latter's delegates did not comment on the arbitration proposal of California, the conference adjourning for the day to allow the California men to caucus on whether or not to answer the Arizona proposal with a definite demand. Members of the California group have stated unofficially that they feel entitled to two-thirds of the lower basin share.

Introducing Our First Water-Power Site!

America's first water power site was built on the Piscatauqua River at South Berwick, Me., on the site of the present Burleigh blanket mills.

It was in 1620 that Ferdinando Gorges obtained a grant from the English crown giving him the right to settle and develop the territory "from sea to sea lying between the 40th and 48th parallels north latitude." The grant, however, required him to develop water power and accordingly he constructed a log dam, erected a grist mill and sent to the meal to England as proof that the terms of the contract were being respected. The water-power site has been in continuous use ever since, and lately came into public notice when the property changed hands.

Gardner Governor Co. Merges With Denver Rock Drill

Merger of the Gardner Governor Co., of Quincy, Ill., and the Denver Rock Drill Manufacturing Co., Denver, Colo., has been announced. The new corporation is known as the Gardner-Denver Company with headquarters at both Quincy, Ill. and Denver, Colo.

This merger brings together two important manufacturing companies in their fields. The products made are complementary to each other and by joining the two lines, the Gardner-Denver Co. offers a complete service to every user of pump, compressors and rock drills.

For over 65 years, the Gardner Governor Co. have been builders of quality pumps, compressors and governors. The Denver Rock Drill Mfg. Co., specializes in rock drills, drill-steel sharpeners, scraper hoists, concrete breakers, and allied accessories.

The two lines are so related that the merger will effect material savings in marketing costs as well as being a decided advantage to buyers, according to the announcement of the merger.

J. W. Gardner will be chairman of the board of the Gardner-Denver Co. and W. H. Leonard, Denver, will be president.

Welcome German Engineers on Study Tour

On Friday, Aug. 19, the North German Lloyd and the American Express Co., were joint hosts to a group of German engineers and architects who landed that day and a number of American engineers invited to meet these visitors and welcome them to our shores.

After an informal reception, an elaborate dinner was served in the main dining salon of the steamship Muenchen, on which the travelers had crossed the ocean. John W. Lieb, chairman of the New York committee on arrangements, served as toastmaster.

Among the speakers were Gustav Lindenthal, manager in America for the North German Lloyd; R. E. Towle, general manager in America for the Siemens and Halske Co. and the Siemens Schuckert Werke, and a number of the distinguished visitors.

The group of about 150 visitors will spend three or four weeks on a tour to be managed for them by the American Express Co., going to various industrial centers of the eastern part of the country for the purpose of studying not only the technical details of architecture and manufacture, but matters of housing and living conditions for people of moderate income.

Fuel and Gas Students Apply Studies at Edgar Station

Arrangements have been completed for students of the course in fuel and gas engineering of the Massachusetts Institute of Technology to carry out field work and testing at the Edgar station of the Edison Electric Illuminating Company of Boston and at other plants.

This course is intended to train graduate engineers in the theory and practice of fuel utilization, gas manufacture, and power generation. The work consists of one academic year of graduate study at the Institute, followed by six months field work. In this field work the theoretical side of fuel and gas engineering studied at the Institute is applied to the actual processes of combustion, gas manufacture, power generation, and oil refining by plant studies, and tests on full scale equipment in commercial operation, all carried out under the immediate supervision of a member of the Institute faculty.

Other field stations of this course are located at the plants of the Cambridge Gas & Light Co., the Lackawanna plant of the Bethlehem Steel Co., the Iroquois Gas Co. and the Bayonne Refinery of the Tide Water Oil Co.

First Unit for Chelan Plant Installed This Week

The first unit of the Washington Water Power Co.'s Lake Chelan hydroelectric development will be in operation about Sept. 1, R. K. Tiffany, Washington State supervisor of hydraulics, announced recently, following his return from a recent trip to Chelan.

The unit, for which the turbine and generator are now set, will develop about 34,000 hp.

The energy will be used in part for hauling trains of the Great Northern Railway Co. over the Cascades. The rest of the energy developed will be diverted to the service lines of the company for use largely in Central Washington.

Machinery for the second unit is now on the way from the factory and when this unit is installed the two units will increase the electric development in the state approximately 10 per cent. Complete plans for the Chelan development call for installation of five units in all.

Welding Conference Planned by Minnesota University

All phases of the welding industry will be considered at a conference held at the University of Minnesota Oct. 20 to 22, according to plans worked out by Professor S. C. Shipley, acting head of the mechanical engineering department of the College of Engineering.

This is the first conference of this nature held by the University of Minnesota, but according to the considerable interest shown by the users of welding equipment in the territory, the holding of such a conference promises to be a yearly event.

A large part is to be given to papers read by practical users as well as round table discussions led by experts in their respective lines.

Three Conflicting Projects in South Up for Review

A preliminary permit covering a project on the Big South Fork of the Cumberland River near the Kentucky-Tennessee line has been requested of the Federal Power Commission by B. G. Slining of Chicago. It is proposed to erect a dam 375 ft. high and to install 80,000 kva.

The application is in direct opposition to that of Edward Allen, also of Chicago, and also conflicts with the application of H. A. Spaulding for a smaller project which would be flooded out by either of the other proposed projects. The Spaulding project contemplates the utilization of a nearby site on the Obed River and another on the Obey River. The commission already has taken jurisdiction over the Cumberland site as a result of action on a declaration of intention filed by Mr. Spaulding.

Argues for Potomac River Development

Benefits which will follow the development of power on the Potomac River in the Washington, D. C., area outweigh the reasons advanced for leaving the river as it is, according to arguments presented by representatives of the Potomac River Corp. at a hearing before the district engineer in Washington, Aug. 23.

Due to the extended period during which the waters of the Potomac are low, it is argued that its scenic features would be improved, rather than injured, by the proposed development.

Brown Hoisting Machinery Co. To Join Industrial Works

Directors of the Brown Hoisting Machinery Co., Cleveland, and the Industrial Works, Bay City, Mich, recently approved plans for the merging of the two companies to be made effective when ratified by their respective stockholders at meetings to be held, it is understood, at an early date. The new company thus formed will be known as the Industrial Brownhoist Corp.

Alexander C. Brown, president of the Brown Hoisting Machinery Corp., who with the late E. B. Perry, formerly president of the Industrial Works, was largely instrumental in the consolidation, will be president.

The consolidation will join under one management over twenty-one hundred workers, and assets of approximately $13,000,000. The combined sales of both companies totaled over $7,700,000 in 1926. Both plants will be continued in operation, and no radical changes of any sort are contemplated.

Turkey Aids Engineering Education

Marked growth in the engineering department of Robert College, Constantinople, is shown in the sixty-fourth annual report just published by President Caleb Frank Gates.

One hundred and thirteen students were enrolled this year in the four year engineering course, and sixty-one in the shorter industrial course requiring two years. With the industrial awakening taking place in Turkey, emphasizing the need of more adequate power plants, the construction of railways and highways and the development of mines and factories, graduates of both of these courses are in great demand, according to Dr. Gates.

The industrial course, started four years ago, prepares skilled engineers and foremen for power plants and machine shops. Instruction is given in the Turkish language. The course is very popular and the number of students is with difficulty limited to the facilities of the school.

The course in electrical engineering has the largest number of students, owing partly to the interest of the Turkish Government which is paying the expenses of twenty-five students in the Engineering College, the majority of who are to be electrical engineers.

John Lyle Harrington of Kansas City, Mo., a former president of the American Society of Mechanical Engineers, was elected to the board of trustees of Robert College during the past year.

Kansas City Power Installs Turbine-Generator Unit

The Kansas City Power & Light Co. of Kansas City, Mo., has just ordered from the Westinghouse Electric & Manufacturing Co. a 10,000-kw., 80 per cent power factor turbine-generator unit. The turbine end of the new unit will be designed to operate with 1,200 pounds gage steam pressure, and 725 deg. F. total temperature at the throttle and will exhaust at 300 pounds gage pressure.

The generator, which is direct connected to the turbine, will be rated at 12,500 kva., unity power factor, producing three-phase 60-cycle current at a potential of 13,200 volts. A direct-connected exciter will be furnished. The combined unit will operate at a speed of 3,600 r.p.m.

Representative Tilson Will Inspect Boulder Dam

Representative John Q. Tilson, Republican, of New Haven, Conn., majority floor leader in the House of Representatives, will leave shortly after September3 for an inspection trip through Imperial Valley and the California site of the proposed Boulder Canyon Dam, it was announced at his office on his behalf on Aug. 24.

Scotland's Electrical Service Now Under Reorganization

The Central Electricity Board, established under the electricity (supply) act, 1926, for the purpose of reorganizing and standardizing the generation and supply of electric current in the United Kingdom, has now issued details of the first extensive development of their proposed program.

This plan, which is known as the Central Scotland Electricity Scheme, 1927, will remain before the public for a period of one month for the purpose of giving an opportunity for criticism or objections, and at the end of the month will be put into operation, with possibly some slight modification. The commissioners contemplate that the board should be able to begin supplying electricity under the design in August, 1929, and estimate that in the four years 1930 to 1934, inclusive, there will be a gross saving to the undertakings in the area of no less than $4,500,000. These savings should increase steadily as the use of electricity grows.

MAIN FEATURES OF THE PROJECT

The plans to be effected are concerned more with organization and distribution of output than on immediate reduction of power costs of improvement in operating efficiency. In the area concerned, covering some 4,980 sq.mi., which includes almost the entire industrial, coal, and shipbuilding activities of Scotland.

The electricity board has been given borrowing powers up to $164,000,000 for the carrying out of the reorganization project for the entire country, and on the basis of the costs submitted by the commissioners in connection with the Central Scotland Scheme, it seems probable that the total expenditure for the entire country will be kept well within the authorized borrowing amount.

It is anticipated that with a reduction in costs and ultimately a reduction in the price to the consumer, the demands for current will, of course, increase at a rather rapid rate. The estimate made by the commissioners in this respect allows for an annual increase of 9 or 10 per cent so that within 10 or 12 years the present demand for electric current in that area should be doubled, and it is possible that even this estimated increase may prove below the actual figure which will be reached. Considerable optimism is expressed, as it is felt that the plan may well lead to a revival and extension of industrial activity in this important Scottish area.

Obituary

O. E. POOLE, Senior, who had served the Dearborn Chemical Co., Chicago, since Sept. 1, 1903, as manager of the Peoria, Ill., branch, passed away at his home in Peoria, the morning of Aug. 1. Burial took place on Aug. 4. Mr. Poole was 71 years of age; while he had not traveled much for some years, he had actively directed the sales organization in his territory until a few months ago, when he suffered a stroke from which he did not recover.

C. L. JOHNSON, who for twenty-eight years had been associated with the Western Electric Co. and more recently an executive in the manufacturing department of that company, died in Pittsfield, Mass. Mr. Johnson was born in Chicago 54 years ago and received his early education there. In 1897 he was graduated from Cornell University, and two years later he entered the employ of the Western Electric Co. in Chicago. In addition to spending two periods in the Chicago branch of the company he was for a time manager of the Northern Electric Co., an associate company located in Montreal. In 1926 he was appointed office procedure engineer in New York City. He was a Mason, a member of the American Society of Mechanical Engineers, the Hamilton Club of Chicago and the Railroad Club of New York.

Personal Mention

PERCIVAL K. REED, formerly associated with the R. H. Beaumont Co., is now chief engineer for the Atlas Conveyor Co. in Philadelphia.

E. A. BALDWIN has been appointed general European manager of the International General Electric Co., with headquarters at Paris, according to an announcement by President Clark H. Minor.

HERBERT L. SEWARD, associate professor of mechanical engineering, Sheffield Scientific School, Yale University, sailed on Aug. 20 on the S.S. Leviathan, in his capacity as consulting power engineer for that vessel.

EDGAR A. CAROLAN, vice president, at his own request has retired from active participation in the work of the company and will reside in France, where he will be available for consultation and advice regarding the affairs of the company in Europe.

W. R. BEAN, formerly research engineer of the Eastern Malleable Iron Co., Naugatuck, Conn., has entered the employ of the Grindle Fuel Equipment Co., Harvey, Ill., as vice-president and consulting engineer to handle both sales and engineering problems in connection with the application of pulverized coal to steam boilers, furnaces or other units.

J. A. FRANKLIN, electrical engineer, formerly of the industrial sales division of the Cincinnati office of the Westinghouse Electric & Manufacturing Co., has been appointed Cincinnati district manager of the Kaestner & Hecht Elevator Co. His appointment was effective Aug. 1. Mr. Franklin was employed at the East Pittsburgh works of the Westinghouse Co. before his transfer to the Cincinnati office.

OWEN D. YOUNG, chairman of the board of directors of the General Electric Co., and Mrs. Young arrived at New York City, Aug. 22, on the S.S. Olympic, having returned after several months sojourn abroad.

WILLIAM H. MAXWELL, JR., formerly representing a group of industrial and business publications, including McGraw-Hill publications, on financial advertising, has discontinued this work and has become associated with Hallgarten & Co. of New York City.

A. T. KASLEY, formerly head of the research department at the South Philadelphia works of the Westinghouse Electric & Manufacturing Co., has been appointed consulting engineer of the engineering department at that plant.

MARCUS A. CURRAN, of New York, at present assistant to the vice-president of the Graybar Electric Co., has been elected vice-president and general manager of the Bryant Electric Co., Bridgeport, Conn. Mr. Curran will assume his new duties on September 1st.

DR. THOMAS STOCKHAM BAKER, president of Carnegie Institute of Technology, returned to this country Aug. 24, arriving on the S. S. France. Abroad Doctor Baker investigated the field of coal distillation in preparation for the international conference on bituminous coal of 1928.

E. H. SCHMITZ has been made district manager of the Pittsburgh office of the Riley Stoker Corp. Mr. Schmitz was at one time in the employ of the Sinclair Oil Co., being affiliated with their combustion engineering department at Houston, Tex., entered the employ of the Tennant Co., consulting engineers in Houston, Tex., specializing in power plant work. He has been with the Riley Stoker Corp. since 1925, devoting his time to experimental developments, and tests.

CLAUDE A. BULKELEY is now associated with the Niagara Blower Co., Buffalo, N. Y., as chief engineer, having direct supervision over the design and installation of all air conditioning equipment and general supervision over all air engineering work carried on by this company. Mr. Bulkeley comes to the Niagara Blower Co. from E. I. duPont de Nemours & Co., Wilmington, Del., where he has for ten years been supervisory engineer of the mechanical experimental division.

LARS G. NILSON has resigned his connection as chief engineer of the Nilson-Miller Corp., Hoboken, N. J., to enter consulting engineering practice, with offices at 1219 Garden St., Hoboken, N. J. Mr. Nilson, who has been active in the Nilson-Miller Corporation for the past eighteen years, will still serve that company as a consultant and retains his interest as a director and stockholder In his consulting practice he will devote himself to the design and development of special machinery and devices.

Business Notes

THE CUTLER-HAMMER MANUFACTURING Co. announces the removal of the Cleveland office from the Guardian Trust Building to the Guarantee Title Building, Suite 1905.

TURBINE PUMP Co. has been incorporated in Portland, Oregon, by John P. Hannon, L. C. Woodruff and Wilbur Henderson, Guaranty Building. The capital stock is reported at $50,000.

ALLEN-BRADLEY Co., 286 Greenfield Ave., Milwaukee, manufacturers of electric control apparatus, recently appointed Robbins & Robbins, 801 Tchoupitoulas Street, New Orleans, Louisiana, as Allen-Bradley representatives in the New Orleans territory. Southern Louisiana and Mississippi and the southwest corner of Alabama will be covered from the new office.

THE FALK CORP., Milwaukee, Wis., manufacturers of herring-bone gears, speed reducers, flexible couplings, oil engines and steel castings, announce the opening of an office in Portland, Ore., at 720 Terminal Sales Building, 12th and Morrison Streets. This office will be in charge of John Jurgensen, who has been in the company's New York office for seven years.

THE ATLAS CONVEYOR Co., recently organized, has opened offices at 20 South Fifteenth St., Philadelphia. L. G. Weygandt and E. A. Thumlert, formerly connected with the R. H. Beaumont Co., are Eastern sales manager and general manager respectively. The company will design and build elevators, conveyors, skip hoists, coal weigh larries, cable drag scrapers, ash hoppers, gates and kindred equipment for the handling and storage of coal, coke ashes and bulk materials.

THE EDWIN BURHORN Co., engineers, contractors and manufacturers of cooling towers, steel plate and castings, will occupy Sept. 1, new offices and shop quarters at the foot of West 5th Street, Bayonne, N. J., in order to facilitate shipments and handle material more economically. This building is located on the main line of the Central Railroad of New Jersey, with direct siding and within easy trucking distance of all main line freight stations and shipping piers for foreign countries.

Trade Catalogs

DUST COLLECTORS — The American Blower Co., Detroit, Mich., has issued bulletin No. 1,028 on equipment for collecting fly-ash and coal dust. Performance, principle of operation and a dimension table are included.

STEAM PURIFIER—Circular 101 of the Hagan Corporation, Bowman Building, Pittsburgh, Pa., entitled "The Wet Steam Problem—How to Solve It," relates to the development, operation and results of the Hagan Steam Purifier.

Coming Conventions

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Refractories Institute will hold its fall meeting Thursday, Sept. 15, at the Clifton Hotel, Niagara Falls, Canada.

American Water Works Association. California Section, at San Jose, Oct. 5-8; Paul E. Magerstadt, sec., East Bay Water Co., Oakland; Central States Section will hold annual meeting at Akron, Ohio, Sept. 15-16; E. E. Bankson, sec., Union Bank Building, Pittsburgh. North Carolina Section, at Durham, Nov. 7-9; H. G. Baity, sec., Univ. North Carolina, Chapel Hill; Southwest Waterworks Association will meet at Hot Springs, Ark., Oct. 10; Lewis A. Quigley, sec., superintendent of City Waterworks, Fort Worth, Tex. Iowa Section, at Council Bluffs, Hotel Chieftain, Sept. 28-30; Jack J. Hinman, Jr., secretary, P.O. Box 313, Iowa City.

American Society of Mechanical Engineers. Calvin W. Rice, secretary, 33 West 39th St., New York City. Seattle, Wash. Section, Aug. 29-31.

American Welding Society, fall meeting at Book Cadillac Hotel, Detroit, Sept. 19-23.

Association of Edison Illuminating Co's, convention at Colorado Springs, Col.; Sept. 26-30.

Canadian Steel and Power Show and technical sessions will be held at the University of Toronto Arena, Toronto, Ont., Aug. 31, Sept. 1 and 2; Campbell Bradshaw, general chairman of exposition committees, 153 University Ave., Toronto, Ont.

Empire State Gas and Electric Association, meeting at Lake Placid, N. Y.; Oct. 6-7.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Fuels Meeting, under the auspices of the Fuels Division of the American Society of Mechanical Engineers, will be held Oct. 10-13 at St. Louis, Mo.

FIRECLAY PRODUCTS—Henry Maurer & Son, New York office at 400 East 23rd. St., have issued a catalog of refractory fireclay products in the form of a well-illustrated booklet. It contains information on the mining of clay and the manufacture of brick, and some mathematical and engnieering tables.

TRANSFORMERS — The Westinghouse Electric and Manufacturing Co. has issued leaflet 20,331 describing single-phase platform-mounting power transformers for 2,300 to 66,000 volts, from 201 to 500 kva.; and leaflet 20,330, superceding 20,138-A, on type SC steel-clad single-phase platform-mounting distribution transformers for use with 33,000, 44,000 and 66,000-volt systems on capacities less than 200 kva.

STATIC CONDENSERS—Tables on corrective kva. required for various ratings of three-phase 60-cycle CS squirrel cage induction motors are included in the Westinghouse leaflet 20286-A. The leaflet is on static condensers for power-factor correction on motor circuits and contains descriptions and illustrations of the various types of condensers. Copies of this leaflet may be had at any of the district offices or from the Advertising Department, East Pittsburgh, Pa.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous	Market	Aug. 17
Net Tons	Quoting	1927
Pool 1	New York	$2.50@$2.75
Smokeless*	Boston	4.25@ 4.40
Clearfield	Boston	1.60@ 1.90
Somerset	Boston	1.70@ 2.00
Kanawha	Columbus	1.25@ 1.60
Hocking	Columbus	1.75@ 1.90
Pittsburgh	Pittsburgh	1.90@ 2.15
Pittsburgh gas slack	Pittsburgh	1.30@ 1.50
Franklin, Ill	Chicago	
Central, Ill	Chicago	
Ind. 4th Vein	Chicago	
West Ky.	Louisville	2.25@ 2.50
S. E. Ky.	Louisville	1.50@ 1.85
Big Seam	Birmingham	1.60@ 2.00

*Gross tons f. o. b. vessel, Hampton Roads.

Anthracite		
Gross Tons		
Buckwheat No. 1.	New York	2.50@ 3.00
Buckwheat No. 1.	Philadelphia	2.50@ 3.00
Birdseye	New York	1.60@ 1.85

FUEL OIL

New York—Aug. 18, light oil, tank-car lots; 28@34 deg. Baumé, 5c. per gal.; 36@40 deg., 5¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis — Aug. 24, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.60 per bbl.; 26@28 deg., $1.65 per bbl.; 28@30 deg., $1.70 per bbl.; 30@32 deg., $1.75 per bbl.; 32@36 deg., gas oil, 4.4c. per gal.; 38@40 deg., 5c. per gal.

Pittsburgh—Aug. 9, f.o.b. local refinery; 30@34 deg., fuel oil, 4¾c. per gal.; 36@40 deg., fuel oil, 5c. per gal.

Philadelphia—Aug. 16, 26@30 deg., $2.05@$2.11 per bbl.; 13@19 deg., $1.68@$1.74 per bbl.

Cincinnati — Aug. 23, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5¾c. per gal.

Chicago—Aug. 20, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 24@26 deg., 95c. per bbl.; 26@30 deg., 97½@$1.00; 30@32 deg., $1.05.

Boston—Aug. 22, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.25c. per gal.; 28@32 deg., 5.75c. per gal.

Dallas—Aug. 20, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

NEW PLANT CONSTRUCTION

Ariz., Phoenix—Plans the construction of an 8 story office building including steam heating system, elevators, etc., here. Estimated cost $600,000. (54).

California—Plans for the construction of a hydro-electric project, 3,294 hp. capacity including power plant and dam 70 ft. high and 430 ft. long, two 750 kw. generators, direct connected to Pelton impulse waterwheels, 55 cu.ft. penstock, etc. (9)

Calif., Davis—Bids for the construction of a central heating plant. Estimated cost $17,000. (2)

Calif., Long Beach—Plans the construction of a hotel. Estimated cost $1,000,000. (48).

Calif., Los Angeles—Contract awarded for the construction of a 13 story warehouse. Vacuum heating and refrigeration systems, electric elevators, etc. will be installed. (1)

Calif., Los Angeles—Contract awarded for the construction of a power plant and boiler house in connection with manufacturing plant. Estimated total cost $7,000,000. (10)

Calif., Los Angeles — Preparing preliminary plans for the construction of an 8 story hotel including steam heating and refrigeration systems, elevators, etc. Estimated cost $1,000,000. (55).

Calif., Los Angeles—Plans the construction of a 9 story bank and office building. Estimated cost $1,000,000. (56).

Calif., Oakland—Contract will soon be awarded for the construction of distributing plant including refrigeration plant, etc. (6)

Calif., Placerville—Plans for the construction of a hydro-electric power development including power plant, 75,000 hp. capacity, dam 172 ft. high and 1,300 ft. long, 200 cu.ft. penstock, transmission lines, etc. on American River. Estimated cost approximately $10,000,000. (8)

Calif., Santa Clara—Plans the construction of an ice and cold storage plant here. Estimated cost to exceed $150,000. (4)

Calif., Santa Cruz—Water distributing system including storage reservoirs, 600 hp. to be developed, 190 ft. fall, maximum amount of water through penstock 30 ft. Estimated cost $350,000. (5)

Ga., Atlanta—Bids until Sept. 13 for furnishing and installing a refrigeration plant. (11)

Ill., Chicago — Contract awarded for masonry, etc. for a 14 story hotel. (49).

Ill., Chicago — Sketches made for the construction of a 10 story apartment. Estimated cost $500,000. (50).

Ill., Chicago—Soon takes bids for the construction of a 13 story apartment building. Estimated cost $900,000. (45).

Ill., Chicago — Sketches made for the construction of a 24 story office and stores building. Estimated cost $1,250,000. (59).

Ill., Chicago—Preliminary sketches made for the construction of a 20 story office and stores building. Estimated cost $2,000,000. (60).

Kan., Abilene—Contract awarded for the construction of a sewage pumping plant. Estimated cost $29,573. (13)

Kan., Liberal — Preliimnary plans prepared for the construction of an ice plant. Estimated cost $60,000. (41)

Mass., Brighton (Boston P.O.)—Bids until Aug. 31 for the constretion of an ice plant. (14)

Mich., Harbor Beach—Plans prepared for the construction of a mill including detached power plant. Estimated cost $180,000. Private plans. (15)

Mich., Wayne—Bids until Sept. 17 for the construction of a pump house. Estimated cost $30,000. (43)

Mo., Larmar—Contract awarded for the construction of an electric light plant including one 360 hp. and one 240 hp. engines direct connected to generators, pumps, etc. Estimated cost $63,850. (17)

N. J., Denville—Bids until Sept. 7 for the construction of a storage tank foundation and pump house. (42)

N. J., North Bergen—Plans prepared for the construction of a school including steam heating system, etc. Estimated cost $850,000. (18)

N. J., Elizabeth—Contract awarded for the construction of a 9 story hotel and stores building. Estimated cost $1,000,000. Steam heating, refrigeration and ventilation systems, boilers, pumps, elevators, etc. will be installed. (21)

N. J., Hackensack—Revised plans prepared for the construction of a 5 story apartment building including refrigeration and ventilation systems, boilers, pumps, elevators eic. Estimated cost $500,000. (22)

N. J., New Brunswick—Sketches made for the construction of dormitories, infirmary, power plant, etc. Estimated cost $150,000. (19)

N. Y., New York—Preliminary plans prepared for the construction of a 15 story apartment including steam heating and ventilation systems, boilers, pumps, elevators, etc. Estimated cost $500,000. (52).

N. Y., New York—Will build a 15 story apartment including elevators, etc. Work will be done by separate contracts. (46).

N. Y., Rochester—Plans prepared for the construction of a 200 x 200 ft. power plant. Estimated cost $1,000,000. (23)

N. Y., New York—Contract awarded for the construction of approximately 35 story office and loft building. (24)

N. D., Mandan—Contract awarded for the construction of a 40 x 80 ft. power plant. Estimated cost $100,000. (25)

O., Cleveland—Preliminary plans prepared for the construction of a 12 story apartment including steam heating, refrigeration and ventilation systems, boilers, elevators, etc. Estimated cost $1,500,000. (26)

Okla., Boswell—Preliminary plans prepared for the construction of a pumping station for Hugo power plant here. Estimated cost $60,000. (27)

Okla., Tulsa—Soon takes bids for the construction of a 15 story bank and office building here. Estimated cost $1,000,000. (47).

Ore., Portland—Contract awarded for the construction of an 8 story hotel. Estimated cost $1,000,000. Steam heating, refrigeration and ventilation systems, boilers, pumps, elevators, etc. will be installed (28)

Pa., Eddystone—Contract will soon be let for the construction of an 8 story office building including electric elevators, etc. (53).

Pa., Philadelphia—Bids until Sept. 6 for repairing power plant stack at Marine Corp. heating plant. (29)

Pa., Philadelphia—Contract awarded for the construction of a boiler house. (31)

Tex., Amarillo—Contract will soon be let for the construction of a 5 story hospital including steam heating refrigeration and ventilation systems, boilers, elevators, etc. Estimated cost $500,000. (57).

Tex., Drescoll—Plans prepared for the construction of a sub-station, also a 22 mi. power transmission line to connect Drescoll with Corpus Christi. Estimated cost $80,000. Equipment for sub-station will be required. (38)

Tex., Fort Davis—A 50 year franchise has been granted to construct an electric light and power plant here. Estimated cost $35,000. Private plans. (39)

Tex., Navasota—Plans prepared for the construction of a dam, on Brazos River near here for irrigation and power purposes, will impound 5,250 acre ft. of water. Estimated cost $100,000. (37)

Tex., San Antonio—Plans prepared for the construction of a 10 story office building. Estimated cost $600,000. (58).

Tex., San Antonio—Contract awarded for the construction of a 25 story office and mercantile building. Estimated cost $2,000,000. Steam heating, refrigeration and ventilation systems, boilers, elevators, etc. will be installed. (40)

Ont., Hamilton — Plans extensions and improvements to pumping station, also construction of a new reservoir. Estimated cost $800,000. (44)

Names and addresses of the responsible parties in charge of the projects listed on this page are available to our readers, and will be furnished upon application. The editors have omitted this information from the current issue for the purpose of measuring the value of new plant construction projects as a regular feature of the paper. Address

A. W. Welch,
Power Information Bureau,
Tenth Ave. at 36th St.,
New York, N. Y.

Equipment Wanted

Boilers, Etc.—Bids until Oct. 21 for three 4,000 hp. water tube boilers, coal pulverizers and burners, etc., for Sewage and Water Board. (73)

Boilers, Air Compressors, Stokers, Etc.—Three 700 hp. water tube boilers, steam driven air compressors, automatic stokers, etc. for proposed power house. Estimated cost $450,000. (61)

Boilers, Pumps, Etc.—Boiler house equipment including portable fire-box type boilers., boiler feed pumps, motor driven centrifugal hot well pump, feed water heater, oil burners, etc. at Naval Operating Base (Submarine Base). (62)

Coal Loading Machine—Electrically operated coal loading machine for proposed new yard. (63)

Electrical Machinery—Bids until Sept. 29 for electrical machinery for Sewage and Water Bd. (64).

Hoist—A 5 drum hoist, with or without motor, about 12 in. drums for equipping 10 in. suction dredge. (75)

Ice Plant Equipment—Equipment for raw water ice plant to increase the capacity from 35 to 75 ton daily. Estimated cost $80,000. (65)

Lighting Plant, Water Pump and Pressure System—Bids until Aug. 30 for the installation of a 110 v. lighting plant, water pump and 400 gal. pressure system in connection with plant at high school. (76)

Pump and Engine—500 g.p.m., 2 stage fire pump and 120 hp. gasoline engine for waterworks. (77)

Pump and Motor—Bids for a 1,000 g.p.h., pump and 3 ph. motor for proposed waterworks improvements. (66)

Pumps—Three 10,000 g.p.m. motor driven centrifugal pumps to be "flood defence" in sewer outlets. (67)

Pumps, Motor, etc.—Bids until Sept. 8 for one 80 g.p.m. single stroke pump, one 100 g.p.m. double stroke pump, one 10 hp. automatic start motor, 3 ph., 60 cycle, 220 v., etc., for proposed waterworks improvements. Estimated cost $15,000. (74)

Pumps, Turbines, etc.—Plans to install pumps, turbines, etc., in proposed dam on Brazos River. Estimated cost $100,000. (71)

Steam Heating and Oil Burning Equipment—Bids until Sept. 1 for steam heating and oil burning equipment including boilers, etc. Cont. 892. (68)

Transformers, Insulators, Etc. — Bids until Nov. 15 for three 4,000 kva. single ph. transformers, two bushings, e.h.t. with current transformers and two h.t. insulators. (69)

Transformers, Cables, Etc.—Bids until Oct. 4 for eight 500 kva. single ph. transformers and accessories; also until Nov. 29 for a 10,000 ft. 6 sq.in. 1 core cable, paper insulated, lead covered, one 2,400 ft. 1 sq.in. 3 core cable, paper insulated, lead covered, single wire armoured, braided and compounded overall, one 200 ft. .0225 3 core cable paper insulated, lead covered, single wire armoured, braided and compounded overall, and one 175 ft. 1 sq.in. 1 core cable, paper insulated, lead covered. (70)